Popular Astronomy.

Vol. XXXVII, No. 8 OCTOBER, 1929 Whole No. 368

NAVAL OBSERVATORY ECLIPSE EXPEDITION TO ILOILO, P. I.*

By PAUL SOLLENBERGER.

The Naval Observatory Eclipse Expedition of 1929 was undertaken chiefly for the purpose of obtaining photographs of the inner and outer corona and the prominences for the purpose of comparison with similar pictures taken at other stations and other eclipses. In particular a schedule was prepared for comparison with photographs to be taken by the Swarthmore College expedition in Sumatra. In this manner it was hoped to obtain information as to any changes which might take place in the corona in a little more than an hour. At the time of writing these comparisons have not yet been made.

The personnel consisted of Commander C. H. J. Keppler, U. S. Navy, in charge, Professor W. A. Cogshall of Indiana University, Mrs. Cogshall, and Astronomer Paul Sollenberger of the Naval Observatory. Lieutenant H. C. Kellers (M.C.), U. S. Navy, went as medical officer and collected a large number of zoological specimens for the Smithsonian Institution and the National Zoological Park. The construction work of the expedition was carried on by petty officers and enlisted men of the Navy.

The selection of the site was naturally a matter of some moment. It was decided at once to locate somewhere in the Philippines, especially in view of the fact that it was desired to be as far distant from the Swarthmore expedition as possible. A careful study was made of climatic conditions in the islands. In this matter the publications of the Manila Observatory were of great value. Father Selga, the director of that observatory, had made extensive investigations of the available sites in advance. Iloilo was selected because its weather record was a little the best, and because it was easily reached. The Philippine Railway Company offered the use of its grounds, across the river from Iloilo. Those grounds were particularly advantageous as they could be reached by naval vessel, because the facilities of the railroad company were at hand, including a warehouse and shop, and on account of the unusually fine spirit of coöperation exhibited by the officials of the company. Transportation between Manila and Iloilo was furnished by naval vessels of the mine sweeper class.

The large scale photographs were taken with a camera of 65 feet focal length, pointed directly at the sun. The lens was supported by an inner tower which was protected from the wind by an outer tower. The

*Communicated by C. S. Freeman, Captain, U. S. Navy, Superintendent, U. S. Naval Observatory.

outer tower was covered with matting and it supported the upper end of the camera tube, the tube and outer tower being completely free from contact with the inner tower and lens. Light insulation between the lens and tube was effected by means of cloth. At the lower end of the tube a small building was erected to house the plate end of the camera, the plate being driven along a runway by means of a centrifugal governor clock. A shutter was provided at the upper end of the tube, operated by a cable from the lower end. A series of exposures ranging from ½ second to 22 seconds in length were made, showing the inner corona and prominences.

For study of the outer corona two cameras of 36 and 46 inches focal length, using rapid lenses, were mounted on a polar axis. Owing to the small scale it was not expected to secure fine detail, but only to show the long extensions. Exposures of from 12 to 65 seconds in duration were made.

Two cameras of about eleven feet focal length were also operated. A coelostat was used to project the light into these cameras. Exposures of from ½ to 52 seconds in length were made during totality. In addition a series of photographs were taken just after the first contact and just before the fourth contact, at intervals of one minute, for the purpose of determining the times of contacts.

There were also several other activities, such as drawings and paintings by interested visitors, eclipse views taken by naval airplanes, radio tests made by a destroyer at Iloilo, and shadow band observations. The latter were undertaken particularly with the object of determining whether or not any bands existed during totality. For that purpose several persons were kept blindfolded up to the time of totality, since it was considered possible that shadow bands previously thought to have been seen during the total phase were due to persistence of the impression received during the partial phase.

On the day of the eclipse the weather seemed very uncertain, and a large heavy cloud was near the sun during the eclipse. In fact a light cirrus veil was over the sun itself, but it was not sufficient in density to affect the results except to some extent in the photographs obtained with the short focus cameras. At least there was no certain visible effect. It is suspected, however, that the seeing may have been somewhat impaired thereby, destroying to a certain extent the fine detail on the large negatives. In no case was the interference so great as to seriously affect the practical value of the negatives for study and measurement.

The plates taken with the eleven foot cameras were excellent and show a large amount of good detail. One of the pictures shown with this article was taken with one of these cameras; the other was taken with the 65-foot camera. (Plates X and XI.)

The results of the radio test were not very conclusive. The shadow band observers were unable to note any bands whatever during totality, although they were easily visible during the partial phases.

A very interesting prominence was visible on the upper or east limb of the sun. Owing to its shape it has usually been referred to as a flag. It extended something more than a hundred thousand miles from the sun's limb, and consisted of a long tenuous portion (the pole of the flag) which the large photographs showed to be double and twisted, at the far end and on one side of which was the main body of the prominence. On the opposite limb there was a very noticeable coronal arch. There were about five principal coronal streamers reaching out from the sun. Two of these, one on the north and one on the south limb, were of considerable length, being faintly visible to a distance of about three diameters from the sun's limb.

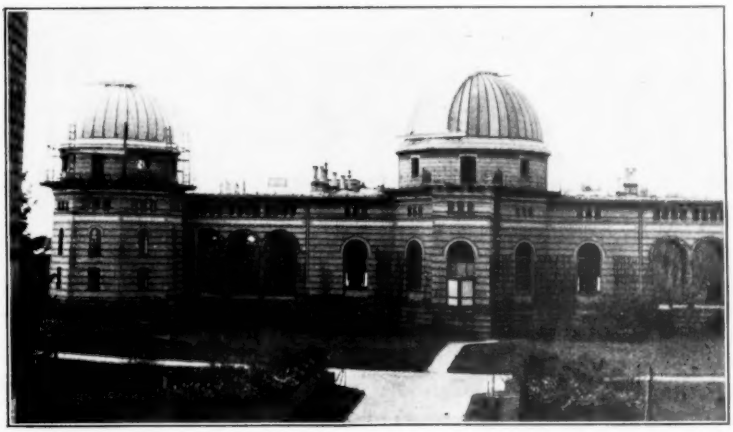
THE ASTRONOMICAL FRATERNITY OF THE WORLD.

By DAVID B. PICKERING.

PART VII.

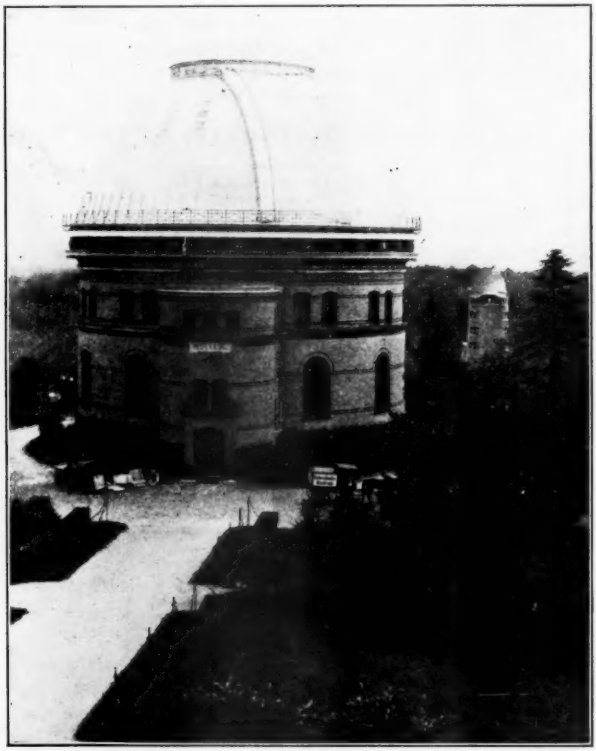
The National Astrophysical Observatory at Potsdam stands high upon one of the many wooded eminences that surround that diminutive but regal town. From the hills one looks down upon a green and blue scene of winding waterways and little islands. The country road that wound upward from the landing where our lake steamer had dropped us was short but steep, so we taxied thence to the entrance gate of the observatory. Not until we reached there did we have our first view of those great brick and stone buildings which house the instruments of Germany's leading observatory.

The institution covers an enclosed area one and a quarter miles in cir-



SECTION OF THE MAIN BUILDING OF THE ASTROPHYSICAL OBSERVATORY AT POTSDAM.

cumference. The central building is in three sections, each supporting a dome and each connected with the other by open galleries. In one section is the office of the Director, and here we found the man who not only heads the staff of this great research laboratory but also is world famous for his work in many branches of astrophysics. To many of us he is especially noted for his signal achievements in the field of variable stars. Physically, as otherwise, Professor H. Ludendorff is a



Dome of 31.5-inch Refractor at Potsdam.

big man. He greeted us in perfect English and at once made us feel entirely at ease by the quiet power of his smile, the twinkle in his eye, and the short, easy, low laugh that broke out refreshingly now and then. During the tour of inspection, upon which we soon embarked, we encountered no other member of the staff and, save for the Professor's seven year old son, no other person whatever.

The older buildings of the observatory were erected in 1874. In the wide entrance hall is a tablet to Emperor Frederick III, whose interest

in science, as the beloved Kronprinz of his people, greatly furthered the establishment of the institution. Nearby stands a portable telescope that the prince presented to an amateur astronomer of that period. Among the instruments originally installed were two pairs of photovisual telescopes; the larger of 31.5 and 19.7 inches aperture, the other of 13 and 9 inches. The optical parts are all by Steinheil while both Repsold and Merz contributed to the mechanical construction. One passes from the wide hall to the room beneath the central dome, and is at once struck by the fact that there is no pier to support the telescope above. This service is performed by converging arches that rest upon the outer walls, much in the manner of that structure which houses Father Hagen's telescope in the gardens of the Vatican. About the walls of this room is arranged the library and in the center is a case containing several historic instruments, among which is the original spectroscope of Kirchoff who discovered the significance of the Fraunhofer lines. Another, of similar type, being the first used by Vogel to determine radial velocities.

From the terrace between the domes, one sees far to the west, the square-towered meteorological building, while here and there between are several smaller domes. To the south stands the imposing structure that houses the great 31.5-inch refractor which was installed in 1899 and, next to the refractor at Meudon, is the largest of its type in Europe. The floor is stationary but an elaborate, motor-driven double-stage platform affords splendid service to the observer. On the upper stage of this platform is a tracked device for attaching a spectroscope to the horizontal tube. To one who has not seen the great American telescopes, the sight of this huge instrument, suggesting as it does such power and majesty, is decidedly awe-inspiring.

Standing still farther to the south is that much-pictured structure, so strikingly different in character from all the other buildings, the now famous Einstein Tower. One's first thought on viewing its solid, gray, shaft-like proportions is that it seems rather diminutive as compared with the massiveness of the older buildings. As we walked toward it, Professor Ludendorff laughingly remarked that some visitor had referred to its architecture as that of the "Arabian renaissance." There are the inner and outer structures, for the external concrete shell is entirely separate from the wooden interior. The 24-inch refractor and the two 32-inch flats, together with all mountings and other equipment, were built entirely by the Zeiss Company and completed in 1923. It was a stiff climb up the winding stairs to the top of its seven stories to see the huge, motor-controlled coelostat surmounting the hollow central shaft. The spectroscope itself is in an even-temperature chamber below the ground level, next to which is a most modern laboratory wherein temperatures of 3000 degrees Fahrenheit may be generated for purposes of making spectra of the elements for comparison. Unfortunately Professor E. Freundlich, the genial Director of this unique observatory, was absent at the time of our visit. Knowing that the in-

strument was dedicated to proving the theories of Professor Edward Einstein, we inquired as to his possible association with it, and were a little surprised to learn that the great mathematician had only once or twice visited the institution that his wonderful discoveries had inspired.

THE EINSTEIN TOWER AT POTSDAM.

We were again back in the Director's study, where hung portraits of Kempf, Schwarzschild, and others, whose genius had brought fame to the fatherland in times of peace. My mind reverted to a beautiful Sunday morning, some weeks previous. We had stood in a beautiful square of Munich amid five thousand silent Bavarians listening to the sonorous tones of a band of a hundred instruments pouring out the profound harmonies of Wagner, and of those ancient hymns of Bach and Handel. No music had ever so stirred us. Standing at my side amid this uncovered throng was a tall man in a long, belted, tan coat whose face was vaguely familiar. We soon learned that he was one of Germany's military geniuses, General Eric Ludendorff. I mentioned this incident to the smiling Professor who sat so quietly at his broad desk, and it led him to tell something of his part in the great war, dur-

ing which he had spent much time in the far east.

Inevitably the mind struggled with the opposing pictures of these two brothers: The genius of might and munitions and the genius whose soul strove to learn the mystery of the stars.

As we left the building to return to town, we saw upon the lawn, a youngster of seven playing American Indian. This sturdy little blonde Teuton was attired in the conventional velvet Bavarian breeches and suspenders, but the toy tomahawk gave him the necessary air of the Wild West. Lucien Ludendorff would now be nine years old. He has a brother of twenty and a sister of seventeen.

The winding walk to the entrance gate was made pleasant by further reminiscences of Professor Ludendorff's. He told us of his two trips to America, on neither of which he visited the United States. Once he had gone to Mexico to witness a solar eclipse and in 1925 had made an expedition to the Potsdam station at La Paz, Bolivia. We expressed the sincere hope that he would come to us in 1932 and view the solar-lunar performance which we expect to stage for the benefit of the International Astronomical Union. At parting he charged us with greetings to all of his American friends. Again we felt the sincere good-will that was conveyed in the firm hand-clasp and smiling farewells.

We strolled down the hill side to the railway station and, with minds vivid with pictures of gaunt gray towers of science and full of the scenes of our latest adventure, returned to the busy metropolis.

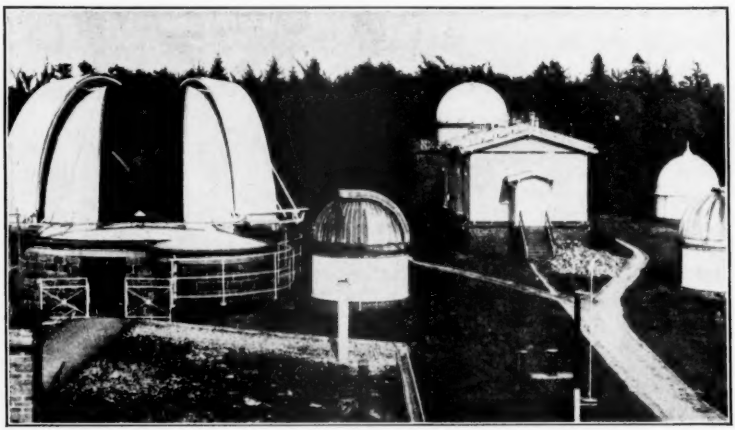
It later became a source of regret that our itinerary did not include a visit to Jena to inspect the great Zeiss plant, whose products mean so much to those who work or play with light.

As our train sped on its way toward Nuremburg we peered from the windows in the hope of catching some glimpse of the Zeiss factory with its planetarium, but we failed to identify it.

Of all European cities, none has a greater fascination, a more appealing charm, than the ancient, walled city of Nuremburg. Its background of tumultuous historic activity as well as of science and art make it well worth long study. It was this Würtemburg town, beloved by Barbarossa, that gave birth to the ancient Minnesingers; here were born Albrecht Durer and Hans Sachs and here the Hohenzollern family began its fateful career. It is the traditional home of toys, and of those marvelous Christmas cakes of blended spice and honey known as Lebkuchen. All this we knew and felt and wondered at during our delightful visit, but it was not until long afterward, too late to make local investigation, that we learned that Nuremburg possessed the first astronomical observatory in Europe. In 1472, in the very hey-day of its glory, one of its wealthy citizens, Bernard Walther, created an observatory for the study of the stars. Work was actively continued until his death in 1504, and for some years during this period Walther had the coöperation of the celebrated astronomer Regiomontanus. Many new observing methods were here introduced. The mural quadrant of Tycho was used for measuring meridian distances and the sextant for deter-

mining distances between the stars. It has been said that the revival of practical astronomy may be dated from the foundation of this institution. And at that time, twenty years were to elapse before Columbus sailed away from Genoa.

Several hours westward by train, in the ancient Principality of the Rhine, on the hilly banks of the Neckar stands the proud and famous town of Alt Heidelberg. It was after dark when our train slipped beneath the many little bridges, that lead the streets across the tracks from the hillside into the town, and came to rest at the station by the open square. That first night in Heidelberg there were no dreams of castles or dueling halls but of a clearing high among the fir trees where, bared to the stars, stood a great array of instruments, commanded by a quiet German genius whose name, perhaps more than any other of his ilk, rings round the world—Max Wolf.



Section of Observatory Grounds at Königstuhl, Heidelberg.

It was a perfect May day. From the Weinmarkt that opens off the square back of the church of the Holy Ghost, one looks up to the ruins of the ancient castle, the lode-stone that attracts thousands to this valley. The slender, steep funicular railway, that rises from here to lose itself among the trees and rocks, makes the first of its three stops at the castle. The second at the Molkenkur, that famous hostelry where the Burgomeisters of Heidelberg so lavishly entertained the astronomers attending the meeting of the Astronomische Gesellschaft in July of last year. Far above, on the summit of the mount, the ascent ends at the Königstuhl, and one looks down, almost vertically, upon a toy town flanked by the blue ribbon of the Neckar, fifteen hundred feet below. From this little station, the road winds through fir and pine that load the cooler air with fragrance. A quarter of a mile beyond one glimpses

through the trees the familiar hemispheres of astronomical domes and senses the approach of another adventure in fellowship. Some time was spent in trying to find an entrance through the high board fence that surrounded the grounds, in the attempt to make a short cut to what seemed the main building, but it was time lost, for we had to return to the far side again and enter by the ancient and prescribed path through a gate that, we later learned, bore the oldest baronial insignia in the province. Not a soul was in sight. We approached a long two-storied brick structure, from one end of which rose a large dome. We rang the entrance bell—no response. We rapped on the door—all was silence. Trees were the only living things we had seen since leaving the funicular. We walked around the building and tried another door with no better result. Just as we were debating as to what method to try next, a grizzled head appeared at an upper window. We mentioned our name and asked for Professor Wolf—for we had phoned that we were coming. A pair of puzzled eyes surveyed us for a long moment and then a voice said "I'll be right down." Soon he was standing in the doorway and we were listening to a half apologetic half whimsical explanation that made clear the puzzled stare which we had seen from below. After our phone call, Professor Wolf had made preparations to receive Professor Wm. H. Pickering, who he had supposed had sent the message. He tried to cover his disappointment, however, and resolved to make the best of it.

Short and stocky he is, with iron-gray hair and beard, twinkling eyes beneath bushy brows, pronounced features whose gentle expression seems to portray an easy, philosophical attitude of mind, a man too big of brain and heart to be handicapped by his ego, and a sense of humor so keen as to mellow every outlook upon life. So we found Max Wolf in 1927, and so we found him again in 1928, when, as the pivotal figure of the great gathering of the Astronomische Gesellschaft, although his energy and patience must have been taxed to the utmost, yet his wit was more sparkling, his humor more dry and his constant cheerfulness more pervasive than ever. His loose-fitting clothes and easy slow manner of movement and speech were indicative of his fullness of years of experience and achievement. Everything he said seemed fraught with wisdom.

In his study, where hung Secchi's original colored drawings of spectra, he showed me a book describing and illustrating Schupmann's "Medal Telescope," an instrument that enables one to eliminate all color from the field by the turn of a screw. He had just returned one which had been sent him for testing and was much impressed with it. He said that through it Venus at sunset had appeared white. Here was one of the Zeiss binocular stereo-comparators, wherein, unlike the usual "Blick" instrument, the two plates are viewed at the same time, stereoscopically. Thus the altered positions of the stars, altitudes of lunar elevations, etc., may be recognized when the knack of seeing is acquired. It is necessary, however, that both eyes be alike, and this condition is so

rare that the machine is not in general service. But Max Wolf's eyes are as well balanced as the rest of him and he makes splendid use of his stereo-comparator.

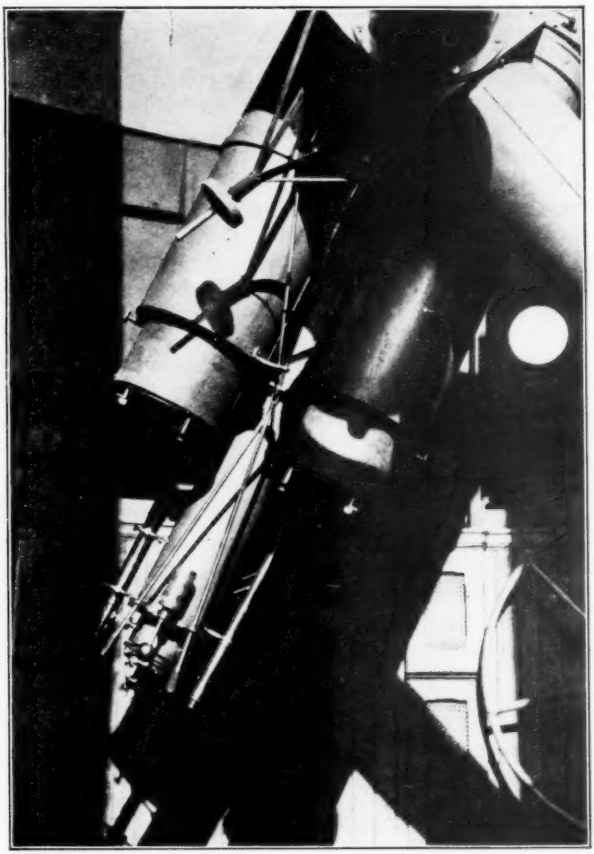
We visited the fine offices and dark-rooms and were struck with the ingenuity of many simple devices used to save time and labor. Here

PROFESSOR MAX WOLF, DIRECTOR OF THE OBSERVATORY AT HEIDELBERG.

I saw, and later adopted, that fine scheme for rocking developing and fixing trays by means of a weighted pendulum attached to the axis of a balanced platform on which the trays were placed. Once the pendulum is set swinging the solutions can be kept in motion for a long time.

From the roof of the main building, one looks out upon a clearing among the scrubby pines splotched with domes, circle houses, and

meteorological equipment. Under the largest dome that abuts the end of the main building is the instrument that Professor Wolf loves best and upon which he most depends. This is a splendid pair of 16-inch photographic refractors with a 10-inch visual attached. He attributes his success chiefly to the fact that all of his work has been done in dupli-



DOUBLE 16-INCH PHOTOGRAPHIC REFRACTORS WITH 10-INCH GUIDING TELESCOPE AT HEIDELBERG.

cate, simultaneous photographs of identical regions being made in order to check any object whose character or position was to be determined. In this connection one recalls the vast number of asteroids and comets which Professor Wolf has discovered, and that it was he who made the first *photographic* discovery of a planetoid.

Each year he adds thirty or forty new worlds to the thousand or so

now known that sail between Mars and Jupiter. Across from the side entrance, to the south of the main building, stands the 28-inch Zeiss reflector, with its accompanying spectroscope. At the date of its installation, 1904, this was the largest instrument Zeiss had ever made. To the east is the dome of the 10-inch Brashear refractor, acquired through the generosity of Miss Bruce of New York. Under a small, red dome is the first telescope owned by the observatory—a 6-inch refractor acquired in 1883. In 1891 the French government awarded a medal to Professor Wolf, but gave him the option of applying its value to additional equipment if he so desired. To know Professor Wolf is to know what his immediate decision would be. That is how the two accessory glasses came to be added to the old 6-inch. There is still another 6-inch refractor and also an 8-inch by Merz under separate domes, as well as large and small transit instruments by Repsold.

As we rambled about, Professor Wolf told of the former sites of this observatory at Mannheim and Karlsruhe in the 18th century. It is now a department of the University and bears the name of the Grand Ducal Observatory. It was located upon the Königstuhl in 1898. There are now upon the staff four assistant astronomers besides computers and other workers. We talked of those fine young men, who, having received their training under him, were now doing splendid work far removed from the Königstuhl—"Wolf's Boys"—among whom we have already spoken of Bernheimer of Vienna and Courvoisier of Neubabelsberg. In the summer of 1928 I sat in a shaded corner of a Rathaus in Heidelberg and, over bratwurst and beer, listened to Professor Dugan of Princeton tell of his happy and profitable years in that old town as one of "Wolf's Boys." One by one these promising astronomers have been lured away because Heidelberg had not the means to compete with Vienna, Berlin, and Princeton. The Director deeply deplored the forced lack of coöperation between the scientists of Germany and other nations during the period of the war. He told of being in America in 1893 and of his visit to Harvard. He praised highly the splendid revision of Young's *General Astronomy* by Russell, Dugan, and Stewart, which had then recently come from the press. In speaking of the late achievements of Shapley, Hubble, and others, he said, with that slow, humorous drawl, as he looked at me out of the side of those twinkling eyes, "America is making so many discoveries now that it seems hardly worth while for me to find anything new—I'm getting too old." I thought of Father Hagen, whose eighty odd years fail to keep him from his beloved telescope, and the thought of this rugged philosopher of sixty-three, whose soul was filled with the thrill of discovery, stepping out of the fray, made me smile. Slowly the mock seriousness passed from his face and he smiled broadly back in return. Ah no, Max Wolf will not step down. Our listening ears shall often hear from him still further news of the stars. How proud the American Astronomical Society was to elect him to honorary membership within a year

from our visit—the first European to receive this distinction since the World War.

It was late afternoon when we entered the fine brick residence which stands on an elevation near the entrance to the grounds. As we approached the picturesque portal, Frau Wolf came to meet us and to invite us to partake of cake and coffee. In the wife of the Director, we encountered that perfect type of *Hausfrau* that in our youth we had found only in the pages of old German tales, tall, straight, and as strong of body as of character. Her iron-gray hair, smoothed at the sides, displayed the firm mouth and soft, motherly brown eyes. And we soon learned how strong and how tender was that motherliness as we sat at *Kaffee* and heard her tell about her boys. The oldest, then 29, had been caught by the great war and, although he had come through unwounded, the strain had much affected his general health. He is now a teacher of physics at Danzig. The second son had recently graduated from the University of Heidelberg and was then in America, selected by the General Education Board of our country, to further his research work in biology. He it was whom I had met at tea with Dr. Annie J. Cannon in Cambridge, some months before sailing. His fond mother told of his boyish hobbies and of his eventual interest in the life habits of insects—his growing passion to learn from Nature the reasons why her children do as they do. I recalled vividly the quiet, dark-haired, deep-eyed youth but did not then guess what friends we were to become during the many visits he subsequently made to our home. Many an evening, after our return to America, we would sit spellbound and listen to Ernst Wolf tell of his adventures with bees, of his endless experiments to test their sense reactions and of his patient observations of their life habits. He is back home now, a Professor of Zoology at Heidelberg University, working in class-room and laboratory but ever hungry for more and more time to apply to his precious research.

Werner, the youngest son, was then finishing his studies at the University. All who attended the Heidelberg meeting of the A.G. last summer, will recall his activities in aiding his father to entertain the members and guests of the Gesellschaft. As interpreter and guide he seemed to be everywhere at once.

As we left the house, Frau Wolf insisted that I must see Ernst's beehives, those which he had acquired as a youngster of fourteen—just another boyish hobby—but which, through the study of their little inhabitants, had resulted in the dedication of his life to biological research. Down through the long grass we passed to the low edge of the garden. Backed by the trees, facing the south, their landing platforms just above the tall grasses, stood the hives. Hundreds of their busy dwellers were returning heavy laden and passing into the little doorways. These were Ernst's friends—his inspiration. The delicious honey-cakes we had just been eating were made from the fruit of their labors. I knew the thrill it would give me to picture this scene to Ernst upon my return.

Frau Wolf was waving her farewells from the grassy hillock as Professor Wolf accompanied me to the ancient gateway. With a full heart I traversed the quiet woods and rode down again past the ruins of the old castle into the town by the placid Neckar.

THE SPECTROSCOPIC CLASSIFICATION OF LONG-PERIOD VARIABLE STARS.

(Third Paper)*

By PAUL W. MERRILL.

All our information concerning the stars has come to us in the light we receive from them,—light, that is to say, in the sense of radiant energy of any wave-length.[1] Our investigations are no longer limited to visible light, for photographic emulsions can record not only all the waves that effect the eye but also a considerable range of both shorter (ultra-violet) and longer (infra-red) waves, while the thermocouple or radiometer is able to yield quantitative evidence of a still further extension into the invisible long wave-length region.

The light of a star is not a single homogeneous thing but a most complex bundle of vibrations of many different wave-lengths. This complexity is not utilized, however, in most types of observation. It may, in fact, be a difficulty in achieving definite and accurate results. This is true of observations of position, in which the star is treated merely as a luminous point, or of determinations of brightness, in which the integrated intensity is the quantity sought. It is not until we come to *spectroscopic* observations that the inherent complexities are revealed and interpreted. In an ordinary observation all the elementary component vibrations are piled together in a small heterogeneous heap called the "image"; in a spectroscopic observation they are laid neatly side by side so that each one can be seen by itself. The weakness or intensification of a certain vibration in the octave or more which can be observed thus

*For preceding papers, see February and May (1929) issues.

[1] Whether we shall ever be able to utilize any other source of stellar information is highly problematical. The so-called "cosmic rays" which have recently come to notice through the observations of Kohlhörster, Millikan, and others may conceivably be connected directly or indirectly with the stars, but these rays are thought to be ethereal vibrations differing from visible light only in having very much shorter wave-lengths. Their wave-lengths are estimated to be of the order of 0.0005 angstrom units. An angstrom unit is one ten millionth of a millimeter. The wave-length of visible light is about 5000 angstrom units.

In addition to ethereal vibrations of various wave-lengths, the stars are, perhaps, continually sending out electrons and even atomic nuclei (alpha particles) or whole atoms, and some of these may reach the earth. The beautiful night display frequently seen in northern latitudes, known as the aurora, has a definite dependence upon the sun and is probably caused by charged particles ejected from that body. Similar particles coming from the stars would have very slight effects upon the earth, and it is not certain that we shall ever detect them.

becomes obvious. The number of vibrations that can be individually recognized depends upon the power of the spectroscopic apparatus, or more precisely upon the "purity" of the spectrum it forms, but in actual practice the number runs into the thousands.

Thus a "direct" observation, that is viewing a star in a telescope, or its image upon a photographic plate, is like looking at a city from such a distance that it appears but a small blur on the landscape, while a spectroscopic observation corresponds to walking along the streets and examining the buildings one by one. Or again, a direct observation is studying a book from the outside, trying to guess its contents by its size, weight, and general appearance; while a spectroscopic observation is opening the book and reading it through, line by line.

Now it is from a detailed study of the individual vibrations, or narrow portions of the spectrum (usually called spectral lines), that we get our greatest insight into the constitution of the stars. With an ease that seems almost magical we can recognize with certainty the existence in stellar atmospheres of atoms precisely similar to those known on earth. We can ascertain, even, what certain constituent parts of the atoms, the electrons, are doing: whether they remain regularly in place forming complete uncharged atoms, or whether some of them habitually stay away from home, leaving the parent atoms electrically upset over their absence.

Future articles will describe at some length the information derived from spectroscopic observations of long-period variables. Here we must restrict ourselves to a consideration of the principles of *classification* of spectra, a clear understanding of which is essential to an appreciation of nearly all recent astronomical research. Fortunately the classification of stellar spectra is a relatively simple matter, far less complicated, for example, than the classification of animals or postage stamps.

The effect of the enormous distances of the variables is greatly to diminish the intensity of their light, but the *character* of each individual ray appears to be absolutely unchanged by its long journey through space. If it is red or blue when it leaves the star, it is red or blue when it arrives at the earth centuries later, and even the minutest spectral details are accurately preserved. The mechanism by means of which light is transmitted is evidently a very exact one, able to carry a beam at terrific speed (186,000 miles per second) for centuries on end without altering its intricate structure in the slightest. Thus the light of a variable star can be analyzed just as if it came from a laboratory source ten feet away. The immense distances of the stars give rise to no difficulty in this connection except to render the light inconveniently faint. The recourse of the observer lies in large telescopes and long exposures on sensitive photographic plates.

Stellar spectra were first examined by Fraunhofer in 1823. He correctly described the spectra of a number of stars, noting that some of them were similar to the solar spectrum while others were markedly different. About forty years later Secchi made a splendid contribution

by examining thousands of stellar spectra and classifying them in four great types. Since then the development of the subject has been rapid and along diverse lines. The following table gives a few of the more important dates in the history of stellar spectroscopy.

1672 Newton discovered the visible spectrum.
1802 Wollaston discovered seven dark lines in the solar spectrum.
1815 Fraunhofer counted more than 750 dark lines in the solar spectrum and measured the positions of 324.
1823 Fraunhofer examined stellar spectra.
1859 Kirchoff and Bunsen established the principles of spectrum analysis and described the chemical composition of the sun.
1863 Secchi's classification of stellar spectra.
1864 Huggins' pioneer work on the detailed analysis of stellar spectra.
1887 Beginning of the Harvard photographic surveys of stellar spectra under the direction of E. C. Pickering.

Secchi's classification, made in 1863, is of great historical interest, and is still useful in referring to the main types of stellar spectra. His own description (quoted below) of the four types into which he divided the stars furnishes an excellent guide to anyone undertaking his first observations of stellar spectra. Amateur astronomers should find it of much interest to attach simple spectroscopes to their telescopes and acquaint themselves with Secchi's four types. The spectra of long-period variables are especially beautiful.

SECCHI'S DESCRIPTION OF STELLAR CLASSIFICATION.

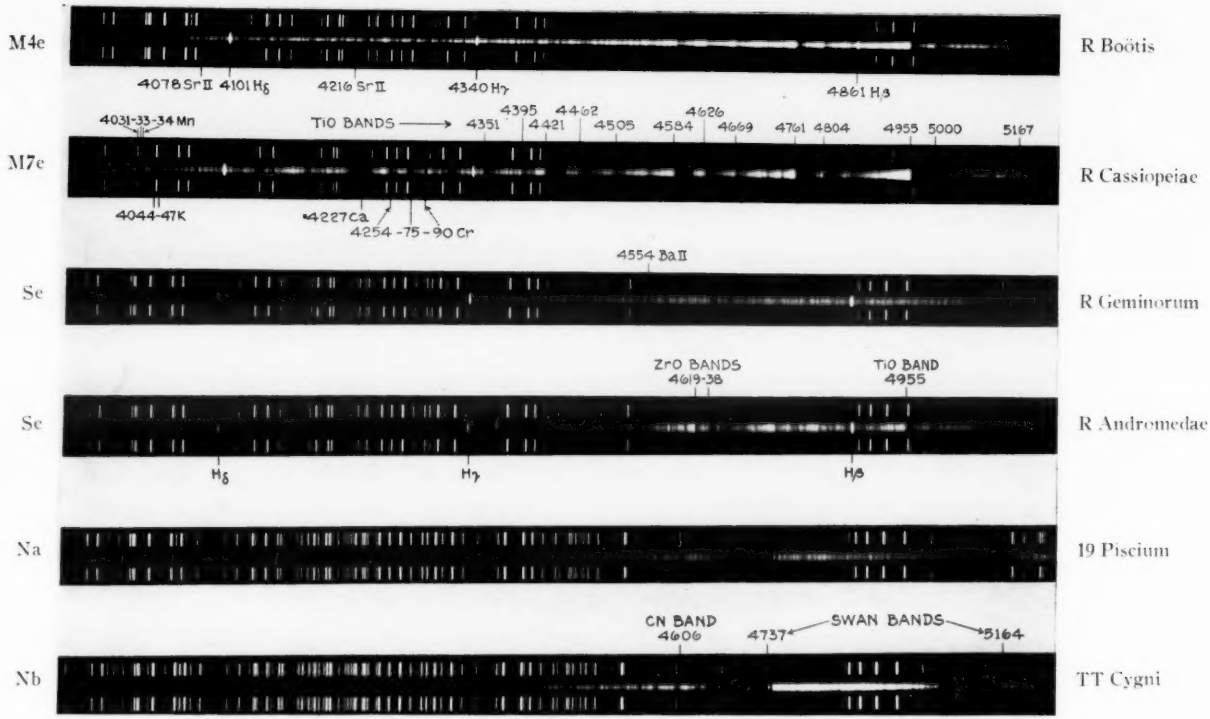
All the stars in relation to their spectrum can be divided into four groups, for each of which the type of spectrum is quite different.

The first type is represented by the stars Sirius, and Vega or α Lyrae, and by all the *white* stars, as α Aquilae, Regulus, Castor, the large stars in the Great Bear, α excepted, etc. The spectra of all these stars consist of an almost uniform prismatic series of colors, interrupted only by four very strong black lines. Of these black lines the one in the red is coincident with the solar line C of Fraunhofer; another, in the blue, coincides with the line F; the other two are also in the sun's spectrum, but they have no prominent place. These lines all belong to hydrogen gas; and the coincidence of these four black lines with those of the gas has been, by careful experiments, already proved by Mr. Huggins, and also lately by myself. In α Lyrae the coincidence is found to be perfectly accurate. Mr. Huggins, however, finds a little difference in the spectrum of Sirius, for which we account in another way, as I will explain presently.

Stars of this first type are very numerous, and embrace almost one-half of the visible stars of the heavens. We observe, however, some difference in individual stars; so that in some the lines are broader, and in others narrower; this may be due to the thickness of the stratum which has been traversed by the luminous rays. The more vivid stars have other very fine lines occasionally visible, but which are not characteristic of the type-form. In this type the red rays are very faint in proportion to the blue, violet, and green, so that the color of the star tends to the blue hue, and occasionally to the green. Of this last kind is the group of the large constellation Orion and its neighborhood.

The second type is that of the yellow stars, as Capella, Pollux, Arcturus, Aldebaran, α Ursae Majoris, etc. These stars have a spectrum exactly like that of our sun—that is, distinguished by very fine and numerous lines. These stars give occasionally a continuous spectrum when the state of the atmosphere is not good; but in general the lines may be distinguished very easily. A fuller description is unnecessary, since the

PLATE XII



STELLAR SPECTRA OF CLASSES M, S, AND N.

Description of Plate XII.

M4e, R Boötis: Plate C2144, 1923 March 1; 12 days before maximum.

M7e, R Cassiopeiae: Plate C4423, 1927 September 10; 11 days after maximum.

Se, R Geminorum: Plate C133, 1919 October 15; 11 days before maximum.

Se, R Andromedae: Plate C4419, 1927 September 9; 12 days after maximum.

Na (No), 19 Piscium: Plate C4058, 1926 October 21.

Nb (N3), TT Cygni: Plate C4351, 1925 August 10.

All the photographs were taken with a one-prism spectrograph attached to the 100-inch Hooker reflector. On the original negatives the dispersion at various points of the spectrum is as follows: Hβ, 57 A per millimeter; Hγ, 36; Hδ, 28. The comparison spectrum is that of the iron arc, the only conspicuous lines of other elements being those of manganese, λλ 4031-33-34. For a detailed study of the illustration, one should have a chart of the iron spectrum. I am indebted to Dr. Sanford for supplying the spectrograms of class N stars, and to Mr. Ellerman for preparing the illustration from the original negatives.

Class M: In comparing the second spectrum with the first, note (a) the increased strength of the titanium bands and the appearance of additional band-heads toward the violet; (b) the relatively slow decrease in the intensity of the continuous spectrum from λ4300 toward shorter wave-lengths; (c) the increased intensity of the low-temperature lines λ 4227 Ca, λλ 4254-75-90 Cr, λλ 4044-47 K; (d) the absence of the bright Hβ line and the increased intensity of Hδ compared to Hγ. The manganese triplet λλ 4031-33-34 occurs both in the stellar and the comparison spectrum. This is true also of several iron lines, for example λ 4046 which, in the stellar spectrum, lies between the potassium lines λλ 4044-47. The lines of ionized strontium (Sr II), λλ 4078 and 4216, are well known "absolute magnitude" lines, being more conspicuous in giant stars than in dwarfs. The presence of ionized atoms is favored by the low densities which prevail in giants.

Class S: Bright Hβ is much stronger than Hγ or Hδ. λ 4554 Ba II and the neighboring line λ4536 (probably a blend of titanium and zirconium) form a fairly conspicuous pair of dark lines. The intensity of λ 4607 Sr depends on the phase in the light cycle: near maximum it is 0.2 to 0.6 as intense as λ 4554, but at other phases it may become 6 to 8 times as intense. In the second spectrum the zirconium bands are stronger than in the first, and the titanium band at λ 4955 is distinctly seen, illustrating the fact that titanium and zirconium bands frequently occur in the same spectrum. When the titanium bands are very strong, the characteristic S-type structure between λ 4626 and λ 4700 is nearly obliterated, but the band-head at λ 4619 may remain visible.

Class N: Notice that, as observed by Secchi, the bands face oppositely to those in class M. Making allowance for the difference in exposure, one sees the absorption in the Swan bands to be much greater in the second spectrum than in the first. The subordinate band-head about 8 angstroms to the red from the principal head at λ 4737 is more conspicuous than on laboratory spectrograms. Although the band at λ 4606 is ascribed to cyanogen, its intensity in various stars is, according to Shane, not closely correlated with that of the cyanogen bands λλ 3883, 4216 (not shown in the illustration).

spectrum of the sun is very well known. The only thing which deserves particular attention is that in this class occasionally the magnesium lines are very strong, so as to produce very strong bands, and the iron lines in the green are in some very distinct. These stars can be distinguished even without the prism by the difference of color, a rich yellow, which contrasts strongly with that of the first type. Stars of this second type are very numerous, and embrace almost the other half of the stars.

The third and very remarkable type is that of orange or reddish stars. These have as a prototype the stars α Herculis, α Orionis, Antares, ο Ceti, β Pegasi. The spectra of these stars show a row of columns at least eight in number, which are formed by strong luminous bands alternating with darker ones, so arranged as to represent apparently a series of round pillars, closely resembling a colonnade. α Herculis is exceedingly remarkable in this respect; the other stars are more or less clearly divided into pillars; but it is quite impossible to describe the beauty of the appearance which is visible in a telescope on a fine night.

Now it is a very remarkable fact that these types seem to differ from one another not in the metallic lines, but in the nebulous bands. Thus, for instance, the spectrum of Arcturus and Aldebaran represent the same metallic lines as α Orionis, but this has bands in addition; the feature, however, is altogether so peculiar that a different type must be constituted. It is to be remarked also that all the pillars have their luminous sides toward the red, while the shadowed sides are toward the violet; this difference is very substantial, as we shall see presently.

The fourth type is not less remarkable. This is the result of a laborious research on the telescopic stars of a red color. Some of these are very small; and none of them exceed the sixth magnitude. This is the reason why in my first memoir I limited the spectra to three types only, being engaged on larger stars only. The spectrum of this type consists of three large bands of light, which alternate with dark spaces so distributed as to have the most luminous side towards the violet.

Extracts from an article entitled "On Stellar Spectrometry" by Padre Secchi, *British Association Reports*, Vol. 38, p. 166, 1868.

Secchi did not fail to note that variable stars furnish many of the finest examples of types three and four.

The scheme of stellar classification now universally employed is the Draper or Harvard classification developed at Cambridge, Massachusetts, about 1890. It was based on an extensive photographic survey of stellar spectra made with the objective prism. After a few preliminary adjustments a form of classification was fixed upon which has served its purpose so well that practically no alterations, other than a few additions, have been needed.

The lines and bands visible in a particular stellar spectrum depend largely upon the effective temperature of the star's outer strata. The classification based on lines and bands therefore becomes practically a temperature sequence. Since color also depends on effective temperature, the arrangement of stars is likewise in order of color. The range of color is somewhat the same as that exhibited by a very hot piece of metal in cooling, *i. e.* from bluish white for the hotter stars to red for the cooler ones, although the hotter stars have effective temperatures exceeding any available in the foundry. The relationship of the Harvard classification to temperature and color is as follows:

Class	Temperature	Color
O	30,000° C (Abs.)	
B	20,000	Blue
A	10,000	
F	7,000	White
G	5,500	
K	4,000	Yellow
M, N, S	3,000 to 2,000	Red

A very brief outline of the principal spectral details characteristic of each class follows. For more complete information the introduction to the Henry Draper Catalogue (*Harvard Annals,* volumes 91 to 99) should be consulted.

Class

O. Lines of ionized helium. Also high excitation lines of a few other elements.
B. Lines of neutral (ordinary) helium.
A. Hydrogen lines and a few metallic lines.
F. Intermediate between A and G.
G. Metallic lines numerous and strong. (Similar to the sun.)
K. Intermediate between G and M.
M. Low temperature metallic lines. Titanium oxide bands.
R. Resembles N but has more blue light. Intermediate between G and N.
N. Carbon (cyanogen and Swan) bands. Blue and violet light weak.
S. Zirconium oxide bands. λ 4554 barium strong.

The relationship of the Harvard classification to that of Secchi is as follows:

Secchi	Harvard
I	B, A, F (including certain stars of class O that resemble those of class B.)
II	F, G, K
III	M
IV	N

We now proceed to a more detailed description of those classes of spectra in which long-period variables are found. These classes comprise the red stars at the low-temperature end of the stellar sequence. The three main spectral groups of red stars are designated by the letters M, N, and S. The following descriptions of these classes with their subdivisions are quoted from the introduction to the great Henry Draper Catalogue of 225,300 stars. Classes K0, K2, and K5 are included to give the continuity. Data concerning the typical stars are assembled in Table I.

Class K0. Typical stars, α Bootis and α Phoenicis. The hydrogen lines are fainter than in Class G5 and the light of the continuous spectrum shows a decided decrease from Hγ to Hε. Hγ is about 0.5 as strong as λ4325.9. Line 4226.9 is 3.0 as intense as in Class G0. Bands H and K reach their greatest intensity. Line 4226.9 is 2.0 as intense as the compound line 4172 and nearly 3.0 as intense as lines 4383 to 4385. The band G, extending from 4299 to 4315, is continuous and is more conspicuous than line 4226.9. Several portions appear brighter than adjacent parts, such as from 4077.9 to Hδ, 4215.7 to 4226.9, 4470 to 4525, and 4614 to 4648, approximately.

Class K2. Typical stars, β Cancri and υ Librae. The spectrum resembles Class K5 in the increased intensities of several lines, as 4226.9, and a general faintness of the continuous portion towards the end of shorter wave-length. The band G is still continuous.

Class K5. Typical star, α Tauri. The bands H and K and line 4226.9 are the most conspicuous absorption lines. The band G is no longer continuous, owing to the disappearance of several of the fainter lines. The double lines 4383 to 4385 and 4405 to 4408 form a conspicuous pair, of which the one of shorter wave-length is somewhat stronger. Faint breaks in the light are seen at the wave-lengths 4762, 4954, and 5168, which are the beginning of the absorption bands of Class M. There is also a sudden diminution in light at Hβ, which is nearly as well marked as the similar change at 4762.

Class Ma. Typical stars, α Orionis and γ Hydri. The spectrum is banded. The bands extending from 4762 to 4954 and from 5168 to 5445 are well marked. The change in light at Hβ is much less conspicuous than at 4762. Several bright spaces are seen, such as from 4556 to 4586, and from 4657 to 4668. The lines of the G band are well separated, and line 4315.2 is very faint. Line 4226.9 is the most conspicuous absorption line. The spectrum is faint towards the end of shorter wave-length, so that bands H and K are generally barely seen.

Class Mb. Typical stars, ρ Persei and γ Crucis. The edges of the absorption bands, at wave-lengths 4762, 4954, 5168, and 5445 are strong and appear somewhat like bright bands. These (apparently bright) bands fade gradually toward the edge of shorter wave-length. Line 4226.9 is very wide and sometimes appears to be as intense as Hδ in the spectrum of α Canis Majoris. Conspicuous bright bands of equal intensity are seen from 4556 to 4586 and from 4614 to 4626. Lines 4299.4, 4300.7 and the compound line 4305.6, 4308.0, and 4309.5 are the only well marked lines remaining of the band G. On isochromatic plates, absorption bands are also seen having edges at the wave-lengths 5763, 5816, and 5857, approximately.

Class Mc. Typical stars, W Cygni and RX Aquarii. The continuous spectrum is fainter, and the bright-edged bands are stronger, than in Classes Ma and Mb, so that the spectrum appears to be of a fluted character, and on plates of small disperson many of the dark lines seem to have disappeared.

Class Md. Typical stars, χ Cygni and o Ceti. This designation is used for spectra of any division of Class M, in which at least one hydrogen line is bright. The greater portion of the variable stars of long period have this class of spectrum. The spectra differ widely. Either Hβ, Hγ, or Hδ may be the strongest bright line, while the underlying spectrum may belong to Class Ma, Mb, or Mc. The subject is further complicated by changes in the relative intensity of the hydrogen lines and probably in the class of spectrum, connected with the variation in the light of the star. As an example, the spectrum of

154615, R Serpentis, may be cited. On April 25, 1912, the bright line, Hδ, was seven times as intense as Hγ, while on April 18, 1914, the two lines were of nearly the same intensity. On the first date, the star was of the ninth magnitude, and the phase was 40 days before maximum. On the second date, the star was at maximum light, about the sixth magnitude. It is evident that no accurate subdivision of these spectra can be made until observations have been obtained at different points on the light curve. It has therefore seemed best to use the designation Md without numeral, in Table I, and to give additional facts, such as the intensities of the bright hydrogen lines, assuming Hγ to be equal to 10, in the Remarks.

Class S.[2] Typical star, π^1 Gruis. The brightest portion, which is between Hβ and Hγ, is of a complicated nature consisting of bright and dark bands. The strongest dark band is at 4554. In the brighter stars, well marked absorption is present at 4227, H, and K. Several variable stars of long period, such as R Andromedae, have spectra of this class, with the addition of bright hydrogen lines, of which Hβ is the strongest.

Class R. This letter was assigned in 1908, to a few spectra which, on photographs of small dispersion, resemble those of Class N between Hβ and Hγ, but which contain so much blue light that the spectrum is visible as far as the calcium bands, H and K. A careful study of these spectra shows that they may be subdivided into at least four classes, which are described below.

Class Ro. Typical star, S.D. —10°5057. The distribution of light resembles that in Class G5 or K0, and the absorption bands H and K are well seen. The dark carbon band at 4700 is wide and strong, and the dark band 4395 is about equal to Fraunhofer's G band. Lines 4226.9, 4233.8, 4236.1, and 4239.0 are well marked, and on photographs having small dispersion the appearance at this region is that of a wide, continuous band of absorption. Some spectra have been found which may be considered to be intermediate between the spectra of Classes K and R0. One of the best examples is the spectrum of the star S.D. —19°3634. This spectrum contains the wide band of absorption near 4227 as in Class R0, and a fainter band at 4700.

[2] Class S was not originally in the Harvard classification but was added in 1922 by the action of the International Astronomical Union at its Rome meeting (see p. 452 ff). The description of Class S quoted above occurs in the last two volumes of the Henry Draper Catalogue (*Harvard Annals*, Vols. 98 and 99). The preceding volumes of the catalogue contain the following statement in regard to these stars: "Several spectra which have hitherto been called Md1 or Md2, in which Hβ is the strongest bright line, are found to be peculiar and are designated Pec. in Table I. The variable stars R Andromedae, U Cassiopeiae, S Cassiopeiae, R Lyncis, R Canis Minoris, T Geminorum, and R Cygni may be given as examples. These spectra do not show the titanium bands having bright edges at 4762, 4954, and 5168 as in all divisions of Class M, but more nearly resemble the spectrum of π^1 Gruis, which may be placed in a subdivision of Class R, assuming some peculiarities."

Class R3. Typical star, B. D. +5°5223. The H and K bands of calcium are visible, but they are fainter than in Class R0, and the continuous spectrum between these bands and Hγ is not more than 0.5 as intense as in Class R0.

Class R5. Typical star, S.D. —3°1685. In the region of shorter wave-length than 4240, the continuous spectrum is barely visible on plates of normal exposure. When the dispersion is small, the spectrum appears to consist of three wide, bright bands, whose centers are at the approximate wave-lengths, 4300, 4400, 4840, and whose intensities are estimated to be 3, 6, and 10, respectively.

Class R8. Typical star, B.D. +61°667. The spectrum is very faint from 4240 to the violet, so that on photographs of long dispersion, it is difficult to distinguish between this Class and Class Na.

Class Na. Typical star, 19 Piscium. The spectrum is visible as far towards the violet as the bands H and K, but the portion between 4240 and K is even fainter than in Class R8. When the dispersion is short, the dark band 4700 separates the spectrum into two wide bright bands,

TABLE I.

Class	Star	H.D.	R.A.1900 h m	Dec.1900 ° ′	Mag.	Remarks
K0	α Boötis	124987	14 11.1	+19 42	0.2	Arcturus
	α Phoenicis	2261	0 21.3	—42 51	2.4	
K2	β Cancri	69267	8 11.1	+ 9 30	3.8	
	ν Librae	139063	15 30.9	—27 48	3.8	
K5	α Tauri	29139	4 30.2	+16 19	1.1	Aldebaran
Ma	α Orionis	39801	5 49.8	+ 7 23	1.0-1.4	Betelgeuse irregular
	γ Hydri	24512	3 48.8	—74 33	3.2	
Mb	ρ Persei	19058	2 58.8	+38 27	3.4-4.2	Irregular
	γ Crucis	108902	12 25.6	—56 33	1.6	
Mc	W Cygni	205730	21 32.2	+44 56	5.0-6.7	Irregular
	RX Aquarii	201882	21 7.3	—14 48	8.0-9.2	Irregular
Md	χ Cygni	187796	19 46.7	+32 40	4.0-13.5	Period 406 days
	ο Ceti	14386	2 14.3	— 3 26	1.7-9.6	Mira; period 332 days
S	π^1 Gruis	212087	22 16.6	—46 27	6.6	
*	DM.—19°3634	113801	13 1.1	—19 31	8.7	
R0	DM.—10°5057	182040	19 17.7	—10 53	7.0	
R3	DM.+ 5°5223	223392	23 44.0	+ 5 50	8.8	
R5	DM.— 3°1685	52432	6 56.1	— 3 6	7.5	
R8	DM.+61°667	25408	3 57.2	+61 32	7.9	
Na	19 Piscium	223075	23 41.3	+ 2 56	5.3	
Nb	ST Camelop.	30243	4 40.8	+67 59	7.0-8.3	Irregular
Nc	S Cephei	206362	21 36.5	+78 10	7.9-13.1	Period 486 days
M0	β Androm.	6860	1 4.1	+35 5	2.4	
M1	ν Virginis	102212	11 40.7	+ 7 5	4.2	
M2	α Ceti	18884	2 57.1	+ 3 42	2.8	
M3	μ Gemin.	44478	6 16.9	+22 34	3.2	
M4	ρ Persei	19058	2 58.8	+38 27	3.4-4.2	Irregular
M5	α Herculis	156014	17 10.1	+14 30	3.5	Variable?
M6	45 Arietis	18191	2 50.2	+17 55	5.9	
M7	R Aquarii†	222800	23 38.6	—15 50	6.0-10.8	Period 387 days
M8	R Leonis‡	84748	9 42.2	+11 54	4.6-10.5	Period 313 days
M9	ο Ceti§	14386	2 14.3	— 3 26	1.7-9.6	Mira; period 332 days

* Intermediate between K and R0.
† Normal maximum.
‡ Normal maximum.
§ Normal minimum.

the portion from 4400 to 4700 being estimated as 0.8 as intense as that from 4700 to 5100. According to this estimate of the distribution of light, spectra of this class may be designated 0, 8, 10, when compared with those of Class R5, in which the bands were estimated as 3, 6, 10.

Class Nb. Typical star, B. D. +67°350. This spectrum may be designated 0, 6, 10, when the distribution of light is considered. The bright portion from 4400 to 4700 is now only 0.6 as intense as the portion of greater wave-length than 4700.

Class Nc. Typical star, S Cephei. The spectrum contains little, or no, light of shorter wave-length than Hβ. The most brilliant portion is from 5900 to 6800.

The International Astronomical Union at its meeting in Rome in 1922 adopted a number of recommendations concerning the classification of stellar spectra. Those affecting the classes which include long-period variables are noted in the following paragraphs.

1. *Decimal system.* "The decimal system of classification (G2, etc.) should be used in all cases in which it is established that a continuous spectral sequence exists. Ma, Mb, and Mc clearly form a sequence running on continuously from K5. It is suggested that they be called in future, M0, M3, and M8, the second interval on the decimal classification being taken wider than the other, because it appears to correspond to a greater difference in the spectra." The numerical notation for the subdivisions of Class M, (M0 . . . . M10), is now rapidly supplanting the older nomenclature. The correspondence between the two systems as determined by usage is about as follows:

Ma = M0, M1, M2
Mb = M3, M4, M5
Mc = M6 .... M10

The report of the Committee of the International Astronomical Union on Classification of Stellar Spectra, presented at the Cambridge meeting in 1925, contains a provisional list of typical stars of subdivision M0 to M9. This list is reproduced in Table I. The selection was based on the increasing intensities of the titanium oxide bands as they are the most suitable criteria for classification. The line spectrum would in general give the same sequence, which is obviously one of decreasing effective temperature. Among the prominent low temperature lines whose increasing intensity may be used as an index of spectral type are λ4227 Ca, and the chromium triplet $\lambda\lambda$4254, 4274, 4288.

2. *Bright lines.* "It is suggested that spectra showing bright lines be denoted by the letter "e" (emission), except in classes where bright lines are normally present (as in O, P, and Q)."

"In certain classes, most of the bright line stars have fairly definite characteristics, and may be considered as forming a recognized group. In these spectral classes, a spectrum which has emission lines differing considerably from those of the recognized group may be denoted by "ep"."

"In Classes M, N, R, and S, the bright lines are usually of the type associated with long-period variability. The hydrogen lines are bright and narrow, with no absorption components visible. In Class M, Hγ is usually bright and conspicuous, while Hδ is still stronger. Hε is absent or extremely weak, Hβ and Hα are weak or absent, except when the underlying spectrum is of an early division of Class M, or possibly a late one of Class K, in which case Hβ, Hγ, and Hδ may have approximately equal intensities. Weaker bright lines, especially at λλ3905, 4138, 4178, and 4202 are not unusual. In stars of Class S, which show bright hydrogen lines, Hβ is much stronger than Hγ or Hδ, though Hγ is usually conspicuous."

"As these differences in the intensity of the hydrogen lines appear to be closely correlated with the underlying spectrum, no additional notation to describe them appears to be called for at present."

"In Classes F, G, and K, bright line spectra are so rare that no characteristic group can be recognized. The mere addition of the suffix "e" may serve for the few known cases, which are far from similar to one another."

The use of the symbol "e" as recommended has now become general and the old designation "Md" denoting any division of Class M in which the hydrogen lines are bright, has been dropped. The spectrum of *o* Ceti for example, formerly classified as Md, is now called M6e.

3. *A new class of red stars.* "Miss Cannon has found that a number of long-period variables and some other red stars, such as π^1 Gruis, R Cygni, and R Andromedae, have underlying spectra which are similar to one another, but do not resemble Class M, and Merrill has shown from slit spectrograms that they do not resemble Classes R or N. Their spectrum in the region λ4500 to 4700 is of a most complicated nature, and appears to consist of both absorption and emission lines, with absorption bands present at about λ4650 and λ6470. Most of the stars belonging to this type are long-period variables and show bright hydrogen lines. The type may represent a third branch of the main spectral sequence, cognate with the K5 — M and R — N branches. The letter S is suggested for this type."

Spectra of Class S are not so well known as those of Classes M and N, and for this reason, a short list of the principal features in the blue region is given in Table II.

TABLE II.

CHIEF FEATURES IN SPECTRA OF VARIABLE STARS OF CLASS Se, λ4500-λ4860.

I.A.	Character	Intensity	Identification
4506.6	abs.	3	Zr?
11.4	em.	var.	...
12.8	abs.	2	Ti?
21.4	em.	var.	...
23.1	abs.	2	Ba?
27.4	abs.	2—	Ti?
35.5	abs.	3	Zr, Ti
40.3	abs.	1—	Zr
54.0	abs.	5	Ba II

TABLE II.—CONTINUED.

I.A.	Character	Intensity	Identification
62.9	abs.	1	...
68.9	max.	...	...
71.3	abs.	2	Mg, —
80.6	abs.	1	V
83.6	em.	var.	Fe II
86.2	abs.	2	V
88.3±	max.	...	...
94.3	abs.	2	V
4606.8	abs.	3	Sr, Zr?
08.7	max.	...	...
13.1	abs.	1	...
14.9	max.	...	...
16.1	abs.	2—	Cr?
18.2	max.	...	...
19.2	band-head	...	ZrO
20.2	abs.	2	...
31.5	max.	...	...
34.1	abs.	2	Zr
36.6	max.	...	...
37.5	band-head	...	ZrO
44.3	min.	...	...
52.4±	max.	...	...
75.1	abs.	1	Ti?
88.0	abs.	2	Zr
4707.1	abs.	1	...
09.9	abs.	1	Zr
58.6	abs.	1	...
84.1	abs.	1	...
99.8	abs.	2	Ti?
4811.7	abs.	1—	...
15.6	abs.	1	Zr
23.6	abs.	1—	Zr?, Mn?
28.0	abs.	2	Zr?
32.0	abs.	2	...

Notes to Table II—

4511.4, 4521.4. These have been observed as bright lines in the spectra of variables of Class Me as well as those of Class Se.

4644.3. Center of a broad absorption space.

4652.4. Broad or double.

4828.0, 4832.0. These lines, although of moderate intensity, are very persistent.

The strong absorption bands in the spectra of Classes R and N correspond to two groups of bands well known in the laboratory under the names "cyanogen" and "Swan." The identification of the molecules which produce these bands has been the subject of much experiment and discussion. It is now thought that the cyanogen bands are in fact produced by cyanogen, CN, but the origin of the Swan bands, named after the man who first measured them, remains in doubt. They may arise from a hydrocarbon or from the carbon molecule, C2. The wave-lengths of the chief band heads are as follows:

Cyanogen bands	Swan bands
3590 A	4383 A
3883	4737
4216	5164
4606	5633
7080	6187

A recent investigation by Dr. Shane at the Lick Observatory[3] emphasized some interesting facts concerning the two groups of bands. The cyanogen bands were found to be strong in Class R but weak or absent in Class N, while the intensities of the Swan bands increase rapidly from R0 to R5, then appear to decrease to a minimum at R8 or Na, after which they again increase toward Nc.[4]

Shane reclassified a number of R and N stars, using decimal subdivisions for both classes. His description of the classification, which closely follows the Harvard system, follows.

CLASSIFICATION

"In classifying the spectra of the carbon stars, it is desirable to consider the region of short wave-length. Among the Class R stars the very characteristic cyanogen bands occur in this part of the spectrum, while in Class N the weakness or absence of the cyanogen absorption is equally important. Moreover the rapid decrease in the spectral intensity toward the violet is of prime significance in classification. If the more refrangible region is not observed, it is possible to fall into serious error. An example is afforded by Classes R5 and N3. If through underexposure the recorded spectrum of a Class R5 star does not extend beyond 4400A, there is little to distinguish it from a Class N3 star, unless high dispersion is employed. This is also exemplified in Classes N3 to N6. The visual spectra of these classes exhibit no appreciable variation throughout the sequence and are therefore not suitable for use in classification.

With these considerations in mind the stars were reclassified according to the following criteria:

Class R0: Cyanogen band strong.[5] Spectral intensity distribution as in Class G or K. Swan bands weak.

Class R3: Intermediate between R0 and R5.

Class R5: Cyanogen bands very strong. Considerably weaker in short wave-lengths than Class R0. Swan bands very strong.

Class R8: Cyanogen bands much weaker than in Class R5. Swan bands show a great range of intensity in this class. Spectral intensity distribution intermediate between Class R5 and Class N0.

Class N0: Cyanogen bands very weak. Spectrum can be photographed as far as H and K only with difficulty. Swan bands weak or moderate.

Class N3: Cyanogen bands missing. Spectrum extremely weak to the violet of 4383A. Swan bands strong.

Class N5: Spectrum very faint to the violet of the Swan band at 4737A. Unidentified bands at 4979A and 4686A strong.

[3] *Lick Observatory Bulletin*, **13**, 123, 1928.

[4] This peculiar behavior, previously noted in part by Rufus and other observers, suggests that the present scheme of classification, based largely on decreasing intensity of the violet light, may not be the best one. Possibly two overlapping sequences or a system in two coördinates may eventually prove more suitable.

[5] The cyanogen group at 4606A was not used in the classification.

Classes N6 and N7: Continue in greater strength the characteristics of Class N5."

It is important for several reasons to understand how the various classes of spectra described in the previous pages are related to one another. We consider here the relationships only so far as they are concerned in the scheme of classification. The physical, chemical, and evolutionary relationships of stars of the various classes, as well as the numerous problems presented by their special spectroscopic features will be discussed in other articles.

The three classes of spectra which include nearly all long-period variables, with their chief distinguishing features are:

Class M.....titanium oxide bands.
Class S.....zirconium oxide bands.
Class N.....carbon bands.

All three refer to red stars and obviously belong near the low-temperature end of the scheme of classification. The principal question which arises is whether they can be fitted into a single series continuing the sequence B - A - F - G - K. Class M has long been recognized as forming an obvious continuation of this sequence. Lines changing their intensity in passing from K to M, continue in general to change in the same sense from M0 to M8. All indications point to a regularly decreasing temperature from K0 to M10. This sequence appears to be without gaps into which other types of spectra can be fitted. Moreover the evidence is very strong that Classes S and N do not belong beyond the end of this sequence. The conclusion is, therefore, that red stars cannot all be arranged in a single linear sequence, but that the classes containing them lie in three parallel branches as illustrated in Figure 1.

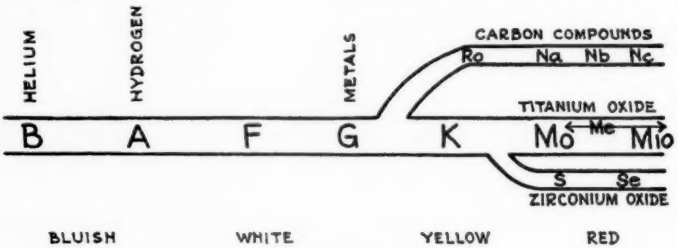


FIGURE I.
RELATIONSHIPS OF THE VARIOUS CLASSES OF STELLAR SPECTRA.

Class N is totally distinct from the other classes, no intermediate or combination spectra being known. It is connected with the main sequence through Class R.[6] Classes M and S, on the other hand, are closely related and have much in common. Strong titanium bands may appear in the spectra of the cooler S-type stars, causing them to re-

[6] For a systematic discussion of this relationship, see Rufus, *Publications of the Observatory, University of Michigan*, **2**, 103, 1916.

semble spectra of Class M, although certain earmarks of Class S remain recognizable, for example the zirconium-oxide band-head at λ4619, and the high intensity of the absorption line λ4554.0 Ba II. Certain stars, including the well-known long-period variable χ Cygni, have spectra intermediate between M and S and the best method of classifying them has not yet been determined.

About nine out of ten long-period variables have spectra of Class M, while the remaining ones are nearly equally divided between Classes S and N. The following data are taken with slight modifications from tabulations[7] by Mr. Campbell and Miss Cannon based on the Harvard Catalogue of Long-Period Variable Stars (1928), which contains 1760 entries. The number of variables with recorded periods greater than one hundred days is 1040, of which the spectral classification is given for 516. The distribution among the spectral classes is indicated in Table III.

TABLE III.

NUMBERS OF VARIABLES IN THE VARIOUS SPECTRAL CLASSES.

Class	With Bright Lines		Without Bright Lines	Total	% of All
	No.	%			
K	3	..	1	4	0.8
M	390	86	63	453	87.8
S	25	89	3	28	5.4
R	3	..	2	5	1.0
N	5	19	21	26	5.0
R & N	8	26	23	31	6.0

For convenient reference, all long-period variables known to have spectra of Class S are listed in Table IV, and those of Classes N and R in Table V. The Harvard designation in the first column shows the hour and minute of right ascension and the degree of declination, for the equinox 1900.0. Southern declination is indicated by italics. The

TABLE IV.

LONG-PERIOD VARIABLES WITH SPECTRA OF CLASS S.

Design.	Name	DM No.	R.A. 1925 h m	Dec. 1925 ° ′	Galactic Long. °	Galactic Lat. °	Magnitude Max.	Magnitude Min.	Per. Days	Spec.
001046	X And	41a	0 12.2	+46 36	85	−15	9.0	14.8	347.0	Se
001838	R And	*58*	20.1	+38 10	86	−24	6.9	13.3	409.2	Se
004047	U Cas	194	42.2	+47 50	90	−16	8.4	14.5	277.6	Se
004958	W Cas	*165*	50.4	+58 10	91	− 4	8.8	11.0	404	(Se)[8]
011272	S Cas	*66*	1 14.1	+72 13	93	+10	8.3	14.5	612.5	Se
043065	T Cam	*422a*	4 32.8	+66 0	111	+13	8.1	13.7	373	Se
045307	R Ori	*768*	54.9	+ 8 1	160	−19	9.5	13.0	378.5	(Se)[8]
065355	R Lyn	1154	6 55.1	+55 26	129	+24	8.0	13.9	379.3	Se
070122a	R Gem	1577	7 2.8	+22 49	162	+15	7.1	13.2	370	Se
070310	R CMi	1428	4.6	+10 9	173	+10	7.9	10.6	338	(Se)[8]
070714	VX Gem	1598	8.6	+14 44	170	+13	*10.8<15*		377	(Se)[8]

[7] *Harvard College Observatory Bulletin*, No. 862.

[8] W Cassiopeiae, R Orionis, R Canis Minoris, VX Geminorum: The spectra of these stars have the S-type characteristics with the important exception of the zirconium oxide bands, which are weak or absent.

Design.	Name	DM No.	R.A. 1925 h m	Dec. 1925 ° ′	Galactic Long. °	Galactic Lat. °	Magnitude Max.	Magnitude Min.	Per. Days	Spec.
074323	T GEM	*1778*	44.8	+23 55	165	+25	8.7	13.7	287	Se
081617	V CNC	1825	8 17.4	+17 31	175	+30	7.7	12.7	272.4	Se
081633	T LYN	1686	18.0	+33 46	156	+34	8.0	12.0	421	Se
123961	S UMA	1313	12 40.7	+61 30	90	+57	7.9	11.5	225.3	Se
142584	R CAM	323	14 23.1	+84 10	86	+33	8.3	13.1	271.2	Se
1446*46a*	S LUP	...	48.4	−46 18	292	+10	8.9	<12	346.0	Se
1517*23*	RW LIB	12248	15 18.7	−23 48	311	*+26*	*8.6*	*11.7*	....	(Se)*
1910*07*	W AQL	...	19 11.3	− 7 11	357	−10	8.4	14.0	493	Se
1910*17*	T SGR	5546	11.9	−17 6	348	−14	8.0	12.8	390.2	Se
193449	R CYG	*3064*	34.8	+50 2	50	+13	7.4	13.9	425.5	Se
194632	χ CYG	3593	47.7	+32 43	36	+ 3	5.1	13.3	406.6	*
200036	AA CYG	3852	20 1.7	+36 36	41	+ 3	8.4	9.2	202	*
200357	S CYG	2134	3.9	+57 46	59	+13	10	16	324	*
201276	SZ CEP	784	12.2	+76 57	76	+22	9.3	<14	327.1	Se
202732a	AD CYG	3850	28.6	+32 19	41	− 5	8.5	9.5	365	S
202817	Z DEL	*4290*	29.2	+17 12	29	−14	9.0	13.9	304.1	*
220133b	RZ PEG	*4335*	22 2.6	+33 9	56	−18	9.0	12.0	442	Se
2357*15*	W CET	6531	23 58.3	−15 6	51	−74	7.4	14.5	351.2	*

* χ Cygni, AA Cygni, S Cygni, Z Delphini, W Ceti: The spectra of these stars combine characteristics of Classes M and S. All except AA Cygni have bright lines.

Durchmusterung number in the third column is from one of three catalogues: for stars north of −23°, the Bonn Durchmusterung; for those between −23° and −62°, the Cordoba Catalogue; for those south of −62°, the Cape Photographic Durchmusterung. Italics indicate that, because of precession, the star is in a zone differing by one degree from the declination for 1925.

TABLE V.

LONG-PERIOD VARIABLES WITH SPECTRA OF CLASSES N AND R.

Design.	Name	DM No.	R.A. 1925 h m	Dec. 1925 ° ′	Galactic Long. °	Galactic Lat. °	Magnitude Max.	Magnitude Min.	Per. Days	Spec.
0122*33a*	R SCL	*525*	1 23.5	−32 56	210	−78	6.2	8.8	376.4	N3
014958	X CAS	334a	51.5	+58 54	99	− 2	9.8	12.1	428.1	(N)
023238	UY AND	525	2 33.7	+38 51	113	−18	*11.0*	<*14.0*	....	N3
032043	Y PER	726	3 22.6	+43 55	118	−10	8.4	10.2	250	N3
044528	TT TAU	707	4 46.8	+28 24	141	− 8	8.1	8.8	166.5	N3
0455*14*	R LEP	*915*	56.2	−14 55	182	−30	7.3	9.8	420	N8
050238	TX AUR	1035	5 3.9	+38 54	135	+ 1	8.5	9.2	330?	N3
052034	S AUR	1044	*22.2*	+34 5	141	+ 1	8.8	10.7	578	N3
053068	S CAM	398	32.9	+68 45	112	+20	8.3	10.6	328	R8e*
061647	V AUR	1291a	6 18.4	+47 45	134	+17	9.1	11.9	352	N3
065041	UW AUR	1556	52.0	+41 13	143	+20	*9.6*	*12.6*	...	N3
0719*22*	— CMA	1850	7 20.5	−22 50	204	− 2	8.6	9.3	217	N3
085120	T CNC	2243	8 52.4	+20 8	175	+38	8.5	10.1	485	N3
1030*53*	TV VEL	....	10 31.5	−53 52	252	+ 4	*11*	<*15*	361?	R8
1046*20*	V HYA	3283	48.6	−20 51	237	+34	6.6	9.0	530	(N)
1206*63*	Z CRU	....	12 7.2	−64 3	266	− 2	*10.8*	*13.5*	...	N0
122001	SS VIR	2694	21.4	+ 1 11	260	+63	6.6	8.7	358	N8
124204	RU VIR	2651a	43.5	+ 4 33	272	+67	8.5	13.0	436	R3e
1250*57*	V CRU	4791	52.1	−57 30	272	+ 5	*10.4*	*13.6*	377	Ne
1331*55*	RV CEN	*5254*	13 32.7	−56 6	277	+ 5	7.0	9.5	460	N3
1459*71*	S APS	1743	15 1.8	−71 46	281	−12	10.0	<13.4	...	R3

* RW Librae: The spectrum is variable and the classification doubtful.

Design.	Name	DM No.	1925 R.A. h m	1925 Dec. ° ′	Long. Galactic °	Lat. °	Max. Magnitude	Min.	Per. Days	Spec.
154639	V CrB	*2929*	46.8	+39 48	30	+50	7.8	11.3	357.5	N3e*
1621*12*	V Oph	4510	16 22.6	−12 16	331	+23	7.4	10.2	297	N3e*
175458a	T Dra	1772a	17 55.2	+58 13	54	+29	9.5	12.1	421	(N)
1811*46*	RS Tel	12279	18 13.2	−46 35	315	−15	*9.5*	*12.0*	...	R0
1824*16*	SS Sgr	4904	26.1	−16 56	343	− 5	8.0	10.5	...	N3
1831*07*	RX Sct	4633	33.0	− 7 40	352	− 2	*9.7*	*12.0*	...	N3
191637	U Lyr	3418a	19 17.5	+37 44	37	+10	9.6	11.8	458	(N)
193732	TT Cyg	3522	38.1	+32 27	34	+ 5	7.3	8.4	400?	N3
200938	RS Cyg	3957	20 10.7	+38 30	44	+ 2	7.2	8.9	413	N3e*
2011*21*	RT Cap	5672	12.7	−21 33	350	−30	6.4	9	...	N3
201437b	WX Cyg	3876	15.8	+37 13	43	0	9.4	12.4	409	N3e*
201647	U Cyg	3077	17.3	+47 39	52	+ 6	7.0	10.6	464	R8e
203847	V Cyg	3167a	38.9	+47 52	54	+ 3	8.9	12.5	420	(N)
204244	RR Cyg	3571a	43.5	+44 36	29	−18	8.5	9.3	367?	(N)
2115*70*	Y Pav	2844	21 17.5	−70 3	290	−39	*5.7*	*8.5*	...	N0
213678	S Cep	*827*	36.2	+78 17	81	+19	8.1	11.3	485.8	N8
215122	RX Peg	4508	52.9	+22 30	47	−25	7.7	8.6	175	N3
224154	TX Lac	....	22 42.8	+54 40	73	− 4	*11.5*	*13.1*	240?	(R)
225745	VY And	4121	58.4	+45 29	72	−13	9.4	10.0	165	(N)
233335	ST And	*4974*	23 35.0	+35 21	75	−25	8.9	11.2	334.2	N3

* Dr. R. F. Sanford has been kind enough to inform me that his unpublished observations at Mt. Wilson show bright hydrogen lines in these spectra.

General References.

1. Introduction to the Henry Draper Catalogue, *Annals Harvard College Observatory*, Vols. 91-99, 1918-1924.
2. Harvard Catalogue of Long-Period Variable Stars, *Ibid.*, Vol. 79, p. 161 (part 3), 1928.

Carnegie Institution of Washington, Mount Wilson Observatory.

THE ANNUAL MEETING OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC.

By MAUD W. MAKEMSON.

The meeting of the Astronomical Society of the Pacific was held this year in connection with a meeting of the Pacific Division of the American Association for the Advancement of Science, in Berkeley, June 19-21.

The research announcement in astronomy was presented by D. H. Menzel in Wheeler auditorium, Wednesday afternoon, June 19. Menzel emphasized the importance of the work of Mt. Wilson and Lick Observatories in confirming the deflection of light, the displacement of spectrum lines toward the red, and the high velocities of distant nebulae predicted on the basis of the Einstein and de Sitter theories of relativity.

On Wednesday evening, an address entitled "The Astronomer's Measuring Rods" was presented by Walter S. Adams who explained the methods of determining the parallaxes of stars and nebulae and illustrated his talk with beautiful slides of these objects made with the Mt. Wilson telescopes.

At the Thursday session at the Students' Observatory, of which R. G. Aitken was chairman, twenty-four papers were read.

Statistics of 296 visual binaries, the components of which have shown indisputable evidence of relative motion in the interval since he first discovered them, was the subject of the opening paper by Dr. Aitken. His measures are published in *Lick Observatory Bulletin* No. 413.

Radial velocities of 742 stars have been deduced from measures of one-prism spectrograms by Adams, Joy, Sanford, and Strömberg, at Mt. Wilson, according to a report by Dr. Adams, and the systematic correction determined by comparison with the Lick measures, obtained with the greater dispersion of the three-prism Mills spectrograph.

Spectroscopic observations of four extra-galactic nebulae were described by M. L. Humason, who, with F. G. Pease obtained the following values for the "apparent" radial velocities:

NGC 4853	+7300	km/sec
NGC 4860	+7800	"
NGC 4865	+4700	"
NGC 7619	+3800	"

A paper by E. Hubble, dealing with intensities in the spectra of nebulae was also read by Mr. Humason.

That the solar motion should be derived from proper motions of stars in the southern sky, was stressed by R. H. Tucker, who paid high tribute to the work of B. A. Gould in observing stars of the Cordoba Zone at the National Observatory of the Argentine Republic.

Dimensions of the Scutum Cloud based on a statistical study of the magnitudes, spectral types, and color indices of 2000 stars were estimated by C. J. Krieger as follows:

Distance of the center of the Cloud	9100 light-years
Diameter of Cloud	1140 light-years
Separation from Local System	5000 light-years
Depth of Cloud	1500 to 3000 light-years

Open star clusters of the Milky Way form a lens-shaped system, according to a statistical investigation presented by R. J. Trumpler. This immense aggregation of star clusters has a diameter of 35,000 light-years and a thickness of 10,000. Our sun is situated in a local system about 12,000 light-years in diameter, with its center 1200 light-years distant from the sun in the direction of galactic longitude 228°.

Analysis of the peculiar velocities of 870 stars of spectral classes O to B5 was the subject of a paper by J. S. Plaskett and J. A. Pearce, for the purpose of testing Lindblad's hypothesis of the rotation of the Galaxy. The distribution of the residual velocities indicated a rotation about a distant but condensed center, the direction of which agreed closely with that determined from the distribution of the globular star clusters.

A paper by H. S. Mendenhall investigated the variable radial velocity and luminosity of Beta Cephei. With a common period of 0.19 day, the velocity and light curves have amplitudes of 30 km/sec and 0.05

magnitudes respectively. An additional variation in the system-velocity of this Cepheid was interpreted in terms of orbital motion of the brighter star as one component of a binary system having a period of twenty years.

Evidence, based on 700 spectroscopic observations, was presented by J. H. Moore that Polaris, now definitely established as a Cepheid variable with a light range of 0.08 magnitude, is at the same time revolving about a common center with an invisible companion in a period of 29.6 years. Observations of the past two years indicate that the star is now repeating the portion of its orbit in which it moved during the years 1896 to 1899. The maximum angular separation occurred in 1921, but the companion of Polaris could not be detected, due doubtless to the faint magnitude.

The extraordinary spectrum of BD +11°4673 was described by Paul W. Merrill. More than 160 emission lines have been observed in the spectrum of this Class Be star, of which nearly all are variable in intensity and position, and some are variable in structure. An 800 day cycle is common to all the elements, but aside from this one feature, each element appears to be a law unto itself.

Photographs of Saturn, Jupiter, Mars, Venus, and Mercury made at Lowell Observatory in red, yellow, and blue light disclosed the most recent developments in planetary study. The outstanding event, according to a paper by E. C. Slipher, read by R. T. Crawford, has been the unusually rapid changes in the south tropical zone of Jupiter. Dark spots showed a recession from the Great Red Spot of 3700 miles per day. Yellow and violet photographs of Mercury were obtained for the first time.

Temperatures of the subsolar points of the full Moon and Mercury have been determined by E. Pettit and S. B. Nicholson from thermocouple measurements to be greater than those calculated directly from the solar constant. They have explained this difference as due to the roughness of the surface causing the radiation normal to the surface to be increased by reflection and radiation from nearby rocks.

Determination of the amount of thermal excitation in the sun by measuring the contours of the 2s-2p and 2d-2p lines of ionized calcium and barium, and comparing the measured degree of excitation with the value calculated from the temperature, was explained by A. Unsöld. For excitation potentials up to 1.7 volts, Boltzmann's law was found to represent the observations, but highly excited atoms were found to be much more abundant than in thermal equilibrium.

Wolf relative sunspot numbers for 1928 indicate that the maximum was reached early in 1927, according to a report on solar activity by E. E. Sternberg and S. B. Nicholson. The present maximum is of the broad type, less pronounced and somewhat lower than in 1917, more nearly resembling that of 1905 and thus confirming the similarity between alternate cycles.

Results of a detailed investigation of photographs of Halley's Comet

were given by N. T. Bobrovnikoff who has found that the values for the repulsive force of the sun fall roughly into two groups: near the nucleus and in the envelopes the repulsive forces are small ranging from two to six times the force of gravitation; in the tail they attain values between 20 and 100 times the force of gravitation.

Extension of the study of the night sky spectrum into the orange and red was described in a paper by V. M. Slipher, read by W. F. Meyer. A remarkable group of strong emission bands has been disclosed, some of which belong to the auroral spectrum and all of which have their origin presumably in the earth's atmosphere.

Publication in the near future of the research surveys of 1091 minor planets was announced by A. O. Leuschner. The comprehensive survey of the minor planets was undertaken three years ago under the auspices of the National Research Council by Professor Leuschner and Dr. H. Thiele, with Mrs. Maud W. Makemson as chief assistant.

Professor Leuschner presented comparisons between theory and observations for twelve Watson minor planets from 1919 to 1929, which indicated that an accuracy far exceeding expectations had been attained by Berkeley astronomers in predicting the motions of minor planets under the disturbing attraction of Jupiter.

Transformation of the fundamental equation in the geocentric distance, of Leuschner's Short Method for computing parabolic orbits, was discussed by R. H. Sciobereti. By plotting a family of parabolas on one sheet of transparent paper and the asymptotic curve on another, Sciobereti has constructed a nomograph which enables him to find graphically the roots of the sextic for any parabola.

Application of Leuschner's method of complete elimination of parallax in the determination of the orbit of Minor Planet 1900 GA was discussed by Mrs. C. H. Smiley (Margaret Holbrook) in a paper presented by Professor Leuschner, who pointed out that her results definitely confuted the statements of European astronomers that the Gaussian methods produced a more accurate orbit in this instance than did Leuschner's modification of the Laplacian method.

Results obtained by Anne S. Young, Director of the Mt. Holyoke Observatory, during the past year at Berkeley, indicate that Comet 1929 *a* may be no other than the lost minor planet (525) Adelaide, according to an announcement by A. O. Leuschner, under whose direction the computation of the orbit of Comet 1929 *a* was executed.

Three astronomical papers were read in the joint meeting with the American Physical Society on Friday morning.

A study of the intensity and form of the spectral lines by the methods of wave mechanics was described by D. H. Menzel, who, following the lead of Dirac, has deduced a formula expressing the theoretical intensity as a function of the line-width for the entire Balmer spectrum of hydrogen. Menzel advanced a unique explanatio nof the peculiar appearance of the rare earth lines as due to a "mirage" of the chromosphere on the photosphere.

A paper by C. E. St. John dealt with three aspects of solar investigation: (1) the actual results thus far obtained; (2) what remains to be accomplished to complete as far as possible a knowledge of the constituents of the sun's atmosphere; and (3) an indication of the lines of investigation promising the most success in further establishing the unity of the material constitution of the sun and earth. In the revision of the Rowland Tables, 4207 additional lines in the region covered by the tables and 1129 in the infra-red have been identified as due to known elements. Out of a total of 21,835 lines in the solar spectrum, 12,502 have been identified. Of the 90 elements known in the Earth, 58 have been recognized in the sun.

Investigation of the solar spectrum in the region between 10,000 and 11,000 A was discussed by H. D. Babcock. This extension beyond previous limits has been attained by excluding from within the spectrograph light of a wave-length shorter than that to be recorded, by preliminary dispersion and by the use of color filters. Over 350 lines beyond the limit of 9867 A, reached by Abney, have been measured at Mt. Wilson.

A social event which added greatly to the enjoyment of the meetings was the reception to visiting scientists by President and Mrs. W. W. Campbell at the President's House on Wednesday afternoon. Dr. Adams' lecture, Wednesday evening, was followed by a reception in Stephens Union. On Thursday evening a dinner at the Claremont Country Club was attended by thirty visiting and local astronomers and officials of the Astronomical Society of the Pacific.

Thirty-five members visited Mt. Hamilton Friday afternoon and evening where they were the guests of Lick Observatory.

University of California, Berkeley.

UNSEARCHABLE GREATNESS.

The myriad twinkling stars roll on in the deep, dense sky of night,
And whirling swift in their unseen tracks swerve not to left or right;
Around and round in their orbits vast they travel on schedule time,
And human insects gaze aloft at the wondrous sight sublime.
The paths of the stars entwine and cross in the soundless depths of space,
But the Power that made them guides their course and keeps each sphere in place.
The Great Dispatcher slumbers not, and His ever watchful eye
Sees suns and systems onward sweep through the maze of the limitless sky.
No noise is heard as the hosts revolve and the heavenly clusters turn,
As the brilliant meteors brightly flash and the plunging comets burn;
The wheels of the universe spin and spin, and harmony reigns supreme,
And its unseen, unknown God directs each move in the mighty scheme:
The countless blazing suns on suns in endless space declare
The strength and pride of the awful Force that hurled and holds them there—
Bespeak eternal energy, a purpose veiled and vast,
A future none can hope to know, a frightful, fathomless past.

The mortal mind is lost in awe too great for tongue to tell,
For the Unknown Power is heavenly high—and deeper far than hell.

William R. Shields.

728 Hancock Street, Brooklyn, N. Y.

PLANET NOTES FOR NOVEMBER.

By CLIFFORD E. SMITH.

The *Sun* during November will be moving southeast from the western part of Libra to the central part of Scorpio. On November 1 there will be an annular eclipse of the sun. The eclipse path begins in the Atlantic Ocean, crosses the central part of Africa, and ends in the Indian Ocean. The position of the sun on November 1 and November 30 will be respectively: R.A. $14^h\ 23^m$, Decl. $-14°\ 13'$; R.A. $16^h\ 22^m$, Decl. $-21°\ 32'$.

The phases of the *Moon* will occur as follows:

New Moon	Nov. 1 at	6 A.M.	C.S.T.
First Quarter	9 "	8 A.M.	"
Full Moon	16 "	6 P.M.	"
Last Quarter	23 "	10 A.M.	"
New Moon	30 "	11 P.M.	"

The moon will be at apogee on November 7, and at perigee on November 19.

Mercury, at the beginning of the month, will be in the central part of Virgo, and will rise about an hour before the sun. During this month it will cross Libra to the central part of Scorpio. On November 27 Mercury will be at superior conjunction. On November 29 it will be in conjunction with Mars. They will be separated from each other at this time by a distance about equal to the diameter of the moon, but unfortunately they will be too near the sun to be seen with the unaided eye. Its apparent motion during this period will be direct.

Venus will have an apparent motion eastward among the stars from the western part of Virgo to the central part of Libra. It will be a morning star during November and will rise about an hour before the sun.

Mars will have an apparent motion eastward among the stars from the central part of Libra to the central part of Scorpio. During this period its apparent position in the sky will be near that of the sun, conjunction occurring December 3.

Jupiter will be in the central part of Taurus a few degrees northeast of Aldebaran, and its apparent motion will be retrograde. On November 18 it will be in conjunction with the moon. During the latter part of the month it will be near the meridian at midnight.

Saturn will be in western Sagittarius and its apparent motion will be easterly. On November 5 it will be in conjunction with the moon, and during the latter part of the month it will set about an hour and a half after the sun.

Uranus will be in the western part of Pisces, and its apparent motion will be westerly. On November 13 it will be in conjunction with the moon, and during the middle of the month it will be on the meridian about 9:00 P.M. Standard Time.

Neptune will be in the central part of Leo, and its apparent motion will be direct. On November 23 it will be in conjunction with the moon, and on November 26, in quadrature west of the sun. During the latter part of the month it will be on the meridian about sunrise.

OCCULTATIONS.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1929	Star's Name	Magnitude	IMMERSION Washington C.T. (h m)	IMMERSION Angle from N (°)	EMERSION Washington C.T. (h m)	EMERSION Angle from N (°)	Duration (h m)
Nov. 3	22 Scorpii	4.8	17 5	112	18 16	263	1 11
5	48 G. Sagittarii	6.3	16 35	86	18 2	264	1 27
16	124 B. Arietis	6.4	4 26	87	5 21	238	0 55
17	22 H.[1] Tauri	6.1	0 48	86	2 1	229	1 14
18	*k* Tauri	5.6	6 22	115	7 11	239	0 50
20	47 Geminorum	5.6	6 36	76	7 31	312	0 56
20	ω Cancri	6.1	22 40	88	23 41	276	1 1
22	90 H.[1] Cancri	6.1	4 20	116	5 40	295	1 20
23	η Leonis	3.6	2 23	120	3 36	288	1 14
26	γ Virginis (*mean*)	2.9	5 17	58	5 43	18	0 26

Prediction of Occultations for Amherst, Mass., and Vicinity.

(Disappearances Only)

Date 1929	Star	Mag.	G.C.T. (h m)	*a* (m)	*b* (m)	P (°)
Nov. 16	124 B. Arietis	6.4	9 31	—0.3	—0.8	72
17	22 H.[1] Tauri	6.1	6 4	—1.7	0.0	77
21	ω Cancri	6.1	3 54	—0.4	+1.4	83
21	4 Cancri	6.2	4 34	—1.8	—2.3	157
22	90 H.[1] Cancri	6.1	9 35	—1.8	—0.2	99
23	η Leonis	3.6	7 38	—1.2	—0.4	106

The G.C.T. of the occultation at some other station within 300 miles of Amherst may easily be found from the coefficients *a* and *b* and the formula

$$\text{G.C.T.} = \text{Predicted G.C.T.} + a\Delta\lambda + b\Delta\phi,$$

where $\Delta\lambda$ is equal to the longitude of the place (to tenths of a degree) minus the longitude of Amherst (72.5 degrees) and $\Delta\phi$ is equal to the latitude of the place (likewise to tenths of a degree) minus the latitude of Amherst (42.2 degrees). For distances up to 300 miles the error of this formula will rarely exceed 2^m.

Roy Marshall.

Detroit Observatory, Ann Arbor, Michigan.

Occultations Observed at Creighton Observatory.

The following is a list of dark limb disappearances recorded on the chronograph of Creighton University Observatory at Omaha during the last year. The Greenwich Civil Time was computed from the sidereal interval between the time of the occultation and the time of the nearest Washington time signal. The time signals were recorded automatically on the chronograph by a relay in the plate circuit of a long-wave radio receiver. Time signal corrections, local relay lag, and personal equation were all taken into consideration, making the time certain to within half a second. Numbers 10, 13, 16, 26 may be a second or more in error due either to haziness or the dimness of the star. Number 21 is probably correct, but some blots on the record render it a little uncertain.

No.	Star	1928		G.C.T. h	m	s
2	161 B. Capricorni	Aug.	30	5	27	13.3
		Sept.				
3	BD —24.16195		25	1	28	16.8
4	BD —24.16193		25	1	30	16.7
5	BD —24.16012		25	3	58	45.5
6	143 B. Capricorni		26	6	59	35.0
		Oct.				
8	Unidentified		23	2	5	57.9
9	Unidentified		24	3	14	39.4
10	257 B. Aquarii		25	3	3	38
		Nov.				
11	Unidentified		20	2	41	4.3
12	336 B. Aquarii		22	3	8	42.1
13	Unidentified		26	2	27	59
14	145 B. Arietis		26	5	1	54.0
		Dec.				
16	Unidentified		19	0	52	26
17	290 B. Aquarii		19	3	56	29.2
18	247 B. Tauri		24	23	32	44.7
19	τ Tauri (1st star)		25	6	40	21.4
20	τ Tauri (2nd star)		25	6	41	51.6
		1929 Jan.				
21	51 Tauri		21	7	45	44?
22	56 Tauri		21	8	19	45.3
23	103 Tauri		22	1	3	8.5
		Feb.				
24	39 Geminorum		20	2	18	43.0
25	η Leonis		23	4	36	3.6
		Mar.				
26	BD 14.469 (?)		15	1	51	40
27	284 B. Tauri		17	2	53	56.9
28	BD 25.866 (?)		18	1	47	20.9
29	BD 25.879 (?)		18	2	6	26.2
30	125 Tauri		18	3	34	40.4
		May				
31	γ Virginis (1st star)		19	5	50	24.3
32	γ Virginis (2nd star)		19	5	50	37.3

Wm. Cletus Doyle, S. J.

Creighton University Observatory, Omaha, Nebraska.

METEOR NOTES.

By CHARLES P. OLIVIER.

The coming of the Perseids in 1929 received extraordinary publicity, due to numerous articles sent out by the Associated Press, Science Service, and other agencies. Instructions were given so that persons who knew little or nothing about meteors could still do something worth while. Also most of the articles were written by men who knew what they were talking about and so the unfortunate features of exaggeration were generally absent.

Thanks to this generous help, the headquarters of the A.M.S. received reports from numerous parts of the country, and from many individuals whom it had never before been able to reach. It is safe, therefore, to say that the Perseids were more extensively observed in 1929 than they had ever been in America. The data are so numerous that all of the results cannot be given this month, and more will be published in subsequent issues. Precedence will be given to reports of non-members, which are mostly hourly counts.

The last few days of July furnished a number of brilliant fireballs seen in various parts of the country. Chief among them was the very fine object (which may indeed have been a meteorite) of July 25 at 9:46 C.S.T., that traversed Illinois from south to north. All records were broken here by over 400 observations being sent in about this body. Their study will take a long time, but fine heights and an orbit should be deducible from them. A very rough preliminary examination seems to show that it ended somewhere near Woodstock, Illinois, at no great height. It is quite possible that fragments may have reached the ground. Definitive study may shift this point a few miles. It is not yet possible to say whether any of the other fireballs seen that night, and within a few days of that date, belong to the same radiant. A special publication will be devoted to this object, and its possible companions.

We welcome as new members the following persons, in order of their joining:

Franklin W. Smith, 407 Scott Ave., Glen Olden, Pennsylvania.
Latimer J. Wilson, Box 63, Franklin, Kentucky.
Miss Mary E. Trimmier, 833 Roscoe St., Chicago, Illinois.
R. C. Welch, 1137 Illsley Drive, Ft. Wayne, Indiana.
H. B. Ransom, 2598 Herschel St., Jacksonville, Florida.
Dean M. Gillespie, 601 E. 18th Ave., Denver, Colorado.
R. H. Axtell, Bates College, Lewiston, Maine.
A. A. Meeker, Charleston, Staten Island, New York.
Franklin F. March, 39 E. 3rd St., Frederick, Maryland.

Examination of the tables will show that the epoch for possible Pons-Winnecke meteors was well covered by a number of our regular observers. A preliminary examination of the maps shows very few meteors which could have come from the direction of the calculated radiant, not more indeed than a mere chance distribution would give. We may safely conclude that no shower was visible.

Results on the Delta Aquarids, including those by McIntosh in New Zealand, will be given later, as well as a study of the radiants from the numerous August observations. As to the Perseids, it is evident that they came to a good and sharply defined maximum on August 11, for their numbers were surely on a decline by the next night. Cloudy weather in many eastern and southern states, on the critical dates, prevented some of our regular observers from seeing the main shower. Also some of the reports are not yet in.

The dates and hours in the accompanying tables are, according to the rule of our publications, given in terms of the (old) astronomical date, beginning at noon.

DR. WM. P. N. CANAVAN, NORTH FALMOUTH, MASS.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 10	12:00	12:30	30	0.4	16	Paths described

J. HANSEN, BITTENDORF, IOWA.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	10:45	11:15	30		12	Counts

MRS. EDNA KENDALL, MILLVILLE, N. J.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 12	14:10	15:00	50	1.0	14	Indoors at window, count

REV. CASPER R. GREGORY,

SUMMIT OF BALD MT. NEAR OLD FORGE, N. Y.

	Began	Ended	Min.	Fac.	Pers.	Others	Total		
Aug. 11	10:30	11:00	30	1.0	21	7	28	N.E.	Counts
	11:00	11:30	30	1.0	18	3	21	N.E.	
	11:30	12:00	30	1.0	28	8	36	N.E.	
	12:00	12:30	30	1.0	21	6	27	N.E.	
	12:30	13:00	30	1.0	22	2	24	N.E.	
	13:00	13:30	30	0.5	3	2	5	N.E.	Clouds
	13:30	14:30	60	...	9	0	9	N.E.	1 interval in obs.
	14:30	15:00	30	1.0	44	11	55	N.E. and S.E.	
	15:00	15:30	30	1.0	65	14	79	Whole sky; several counting.	
	15:30	15:45	15	1.0	21	1	22		
	Totals				252	54	306		

EDWARD H. SPICER AND GRANT LAWSON,
STATE SANATORIUM, MARYLAND.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 11	13:00	14:00	60	1.0			42	One observing; region near Perseus
	14:00	15:00	60	1.0			45	
	15:00	16:00	60	1.0			54	
					110	31	141	All mapped
			180	1.0			45	Other parts sky
	Total						186	

W. H. MARTIN,
YOSEMITE NAT. PARK, CALIF. Elevation 8500 ft.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	12:30	13:30	60	1.0	49	Counts
	13:30	14:30	60	1.0	62	
	14:30	15:30	60	1.0	57	
	15:30	16:10	40	1.0	21	
	Total				189	

W. E. PFISTER AND E. A. PFISTER, NEWFIELDS, N. J.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 12	10:30	12:00	90	0.9	35	N.E. Many described
	12:30	14:00	90	0.9	46	
	Total				81	

CARL P. SCHOFER, NASHVILLE, TENN.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 4	8:30	10:30	120	0.9	8	All plotted
5	8:00	9:45	105	0.5	5	All plotted
6	8:00	10:30	150	0.9	11	All plotted
7	8:00	9:30	90	0.9	5	All plotted
11	12:00	13:00	60	0.6	7	
	13:00	14:00	60	1.0	14	
	14:00	15:00	60	0.9	20	
	Not timed				6	
11	Total				47	41 plotted
12	11:30	12:00	30	1.0	4	
	12:00	13:00	60	1.0	24	
	13:00	14:00	60	1.0	19	
	14:00	15:00	60	1.0	16	
	Not timed				7	
12	Total				70	58 plotted

DR. MAURICE H. TALLMAN, MIAMI, FLORIDA.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 7					3	0	3	All plotted
10	15:36	17:15	99	1.0	10	0	10	All plotted
11	11:15	13:	105	0.8	3	5	8	All plotted
	13:10	14:10	60	0.8	18	4	22	All plotted
	14:10	15:10	60	0.8	20	5	25	All plotted
	15:10	16:00	50	0.8	5	3	8	All plotted

NOTE: Dr. Tallman was confined to his bed by a serious injury. He had to observe therefore from a porch, the roof of which permitted him to see the eastern sky only about half way to zenith.

FRANK BEEN, PARK NATURALIST, SEQUOIA NATIONAL PARK, CALIF.
On Moro Rock, Altitude 6719 feet.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	9:05	14:30	325	...	216	Count by 15 persons

MRS. E. E. BLAAUW, NEAR COLLINS CENTER, N. Y. Altitude 1300 ft.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	8:35	9:05	30	0.5	9	Moon up
	9:25	9:55	30	0.9	7	
	10:00	10:30	30	0.9	5	
	10:30	12:00		?	5	Clouds

NOTE: Assisted by Mrs. J. Pettit, but above numbers are for one observer.

E. R. TINKHAM, PRESIDIO, TEXAS.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	17:00	17:50	50	1.0	9	All mapped

MISS EMILY R. HUEY, WEST CHESTER, PA.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 12	11:15	12:15	60	0.5	7	Paths described

DR. PAUL W. MERRILL, PASADENA, CALIF.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 11	11:00	11:30	30	0.7	19	1	20	Counts
	11:30	12:00	30	0.7	13	2	15	
	13:00	13:30	30	0.7	11	1	12	
	13:30	14:00	30	0.7	12	4	16	
	14:00	14:30	30	0.7	13	5	18	
	14:30	15:00	30	0.7	9	2	11	
					77	15	92	Counts

MISS EVALYN E. GARDNER, FELLOWS, CALIF.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 9	8:00	9:30	90	1.0	15	Counts
	12:00	14:00	120	...	126	
10	8:00	10:00	120	1.0	100	
11	11:30	12:00	30	1.0	52	
	12:00	13:00	60	...	118	
	13:00	14:00	60	...	117	
	14:00	15:00	60	...	164	
	15:00	16:00	60	...	157	
12	12:00	13:00	60	1.0	120	
	13:00	14:00	60	...	101	
	14:00	15:00	60	...	117	
					1187	Counts

MISS MIRIAM L. HALLORAN, LITTLE YORK LAKE, N. Y.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	12:00	12:30	30	1.0	17	20 girls took part in
	12:30	13:00	30	1.0	63	the counting
	13:00	13:30	30	1.0	39	
	13:30	14:00	30	0.5	18	
	14:00	14:30	30	0.7	35	
	14:30	15:00	30	0.7	20	
	15:00	15:30	30	0.7	25	
					217	Counts

ROGER DANIELS AND DONALD E. CROWLEY, PARISHVILLE, N. Y.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	8:30	9:00	30	0.8	4+	Counts; but many of the
	9:00	9:30	30	0.3	3	brighter ones fully
	9:30	10:00	30	0.5	11	described
	10:00	10:30	30	0.7	19	
	10:30	11:00	30	0.8	40	
	11:00	11:30	30	0.8	33	
	11:30	12:00	30	0.8	34	
	12:00	12:30	30	0.8	45	
	12:30	13:00	30	0.8	40	
	13:00	13:30	30	0.8	47	
	13:30	14:00	30	0.8	56	
	14:00	14:30	30	0.8	74	
	14:30	15:00	30	0.8	50	
	15:00	15:30	30	0.8	70	
	15:30	16:00	30	0.5	28	
					554	Counts

MISS MARY D. GALLIGAN, LANESBORO, MINN.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 12	11:45	12:15	30	0.7			14	C.S.T.
	12:15	12:45	30	0.7			13	
	12:45	13:05	20	0.7			11	
	Total				30	8	38	All plotted

FRANKLIN F. MARSH, FREDERICK, MARYLAND.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 11	15:31	16:31	60	0.8			26	
12	14:00	14:55	55	1.0			22	
	Total				40	8	48	All plotted

MISS MARY ANDERSON, NAPLES, MAINE.

	Began	Ended	Min.	Factor	Meteors	Notes
July 21	9:00	10:00	60	0.7	2	E.S.T. All plotted
Aug. 2	10:30	11:00	30	1.0	3	All plotted
9	8:45	9:15	30	0.9	6	All plotted
17	7:30	8:30	60	1.0	5	All plotted
28	7:30	8:30	60	1.0	2	All plotted

R. H. AXTELL, GATUN, CANAL ZONE, PANAMA.

	Began	Ended	Min.	Factor	Meteors	Notes
July 29	9:00	9:40	40	0.6	11	Counts
Aug. 1	10:10	11:00	50	...	15	Counts
11	15:00	15:40	40	0.4	27	Counts

ALBERT A. MEEKER, CHARLESTON, STATEN ISLAND, N. Y.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 10	16:30	17:30	60	0.5	5	D.S.T.
11	9:30	10:30	60	0.5	7	

BALFOUR S. WHITNEY, MIAMI, OKLAHOMA.

		Meteors	Notes
Aug. 15	(Preliminary report only)	32	All plotted

GOODRICH WATKINS, CALDWELL, IDAHO.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 9	13:00	15:15	135	1.0	38	5	43	
10	13:00	15:00	120	0.9	38	4	42	
							85	All plotted

PROF. ASAPH HALL, FLOWER OBSERVATORY, PA.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 12	10:25	12:12	47	0.4	5	7	12	
	12:12	12:45	33	0.5	4	1	5	
	12:45	13:00	15	0.4	1	1	2	
			95				19	Counts

CHAS. P. OLIVIER, FLOWER OBSERVATORY, PA.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 12	9:52	13:02	180	0.4	18	8	26	

RICHARD G. CLARK, FRANKLIN, PA.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 10	12:00	14:30	150	0.7	18	6	24	
11	8:30	10:30	120	1.0	15	4	19	3 brilliant

STIRLING ALEXANDER, YOSEMITE NAT. PARK, CALIF.,
TUOLUMNE MEADOWS. ALTITUDE 8600 ft.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 11	12:30	13:00	30	1.0	39	5 out of 6 Perseids; only
	13:00	13:30	30	1.0	37	those counted which were
	13:30	14:00	30	1.0	43	surely seen. Half as many
					119	more possibly seen.

LEONARD SOBELMAN, MILLVILLE, N. J.

	Began	Ended	Min.	Factor	Meteors	Notes
Aug. 12	10:15	11:00	45		9	
	11:00	12:00	60		23	
	Total				32	

REV. ROBERT G. HARBUTT, PENNEY FARMS, FLORIDA.

	Began	Ended	Min.	Fac.	Pers.	Others	Total	
Aug. 11	11:45	16:00	?	?	43	6	49	in clear intervals

H. B. RANSOM, JACKSONVILLE, FLORIDA.

		Meteors
Aug. 11	Short watches at 11, 14 and 16 hrs.	1

J. F. AHERN, JACKSONVILLE, FLORIDA.

			Meteors	Notes
Aug. 11	11:00	12:00	2	"many small and swift"

Occasional meteors, usually bright, were reported by:

	Total
Arthur L. Church, Philadelphia, Pa.	2
W. E. Lamb, Niagara Co., N. Y.	4
L. J. Guigon, Shreveport, La.	3
C. H. Farmer, Hayfork, Calif.	12

Passengers on *S.S. Gatun* reported "vivid display" on August 11.

CLINTON B. FORD, ANN ARBOR, MICH.

		Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
July	25	9:35	10:35	60	0.7	2	2.0	2.9	
	27	11:30	13:00	150	0.5	5	2.0	4.0	
	28	11:30	13:30	120	1.0	16	8.0	8.0	
	31	11:30	13:30	120	0.9	29	14.5	16.1	
Aug.	1	12:00	14:00	120	0.9	32	16.0	17.8	
	3	11:40	14:00	140	1.0	28	12.0	12.0	
	4	11:40	13:40	120	1.0	36	18.0	18.0	
	7	11:00	13:00	120	0.9	18	9.0	10.0	
	9	11:30	14:00	115	0.8	29	15.0	18.8	
	11	11:00	14:00	180	1.0	71	23.7	23.7	
	11	11:00	14:00	180	1.0	196	65.3	65.3	Count by R. J. O'Hara

JOHN J. CONBOY, LAWTON, OKLAHOMA.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate
May 31	10:30	14:00	210	1.0	30	8.6	8.6
June 7	11:30	13:00	90	0.8	23	15.3	19.2

TEXAS GROUP. C.S.T. USED.

NOTE: All observed in or near Ft. Worth, Texas, except Logan at Dallas.

ROBERT BROWN.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate
June 25	9:18	11:01	103	0.8	6	3.5	4.4
26	8:57	11:05	128	0.8	5	2.3	2.9
27	10:13	12:20	127	0.9	10	4.7	4.7
29	10:45	14:32	227	0.8	28	7.4	9.2

BLAKENEY SANDERS.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate
June 26	8:57	11:10	73	0.7	4	3.3	4.7
27	10:25	12:26	121	0.8	14	7.9	9.9
29	10:47	14:28	221	1.0	24	6.5	6.5

J. H. LOGAN.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
June 7	10:25	11:25	60	1.0	3	3.0	3.0	in S.E.

STERLING BUNCH.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate
June 25	8:57	9:45	48	0.8	5	6.3	7.9
27	9:00	10:15	75	1.0	9	7.2	7.2
29	10:48	14:32	224	0.8	32	8.6	10.8
26	8:43	9:20			2		

O. E. MONNIG.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate
June 23	9:14	10:32	68	0.5	0	0.0	0.0
25	9:00	11:01	121	0.7	5	2.5	3.6
26	8:57	11:03	124	0.8	4	1.9	2.4
27	10:13	12:20	127	0.9	16	6.5	7.2
28	10:32	11:35	63	0.8	4	3.8	4.8
29	10:48	14:32	224	0.8	26	7.0	8.8

B. C. DARLING, LANSING, MICHIGAN.

	Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
June 16	10:00	14:45	124	0.6	6	2.9	4.8	
25	9:33	10:40	67	1.0	7	6.3	6.3	
26	9:22	11:24	122	0.9	4	2.0	2.2	
28	9:15	10:25	70	1.0	0	0.0	0.0	
29	9:37	10:05	28	0.4	0	0.0	0.0	
29	10:00	10:30	30	0.5±	2	4.	8.	by assistant
July 2	9:48	10:25	37		1	1.6		
5	10:00	10:54	54	0.7	0	0.0	0.0	
7	9:20	10:45	85	1.0	7	4.9	4.9	
9	9:50	10:45	55	0.7	6	6.5	9.3	
10	9:52	10:20	28	0.4	1	2.1	5.2	
12	9:30	12:30	180	0.7	9	3.0	4.3	Moon
13	10:15	12:15	112	1.0	6	3.2	3.2	
15	9:14	9:55	41	0.6	1	1.5	2.5	
19	9:23	11:36	105	0.5	2	1.1	2.2	
21	9:05	10:05	60	0.3	0	0.0	0.0	Full moon
22	9:15	10:15	60	0.3	1	1.0	3.3	
24	9:35	10:07	32	0.2	0	0.0	0.0	
25	9:17	10:44	85		1	0.7		
26	9:00	11:33	153	0.8	8	3.1	3.9	
27	9:07	12:34	207	0.5	14	4.1	8.2	
28	9:01	12:35	205	0.9	14	4.1	4.6	

		Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
July	29	9:56	12:38	158	1.0	26	10.3	10.3	
	30	9:00	10:48	108	0.9	7	3.9	4.6	
Aug.	3	10:09	12:10	139	0.8	17	7.3	9.1	4 later
	4	9:20	13:18	168	1.0	26	9.3	9.3	4 later
	6	10:25	12:39	134	1.0	18	8.1	8.1	
	7	10:13	13:00	167	0.9	23	8.3	9.2	
	8	11:17	13:00	103	0.5	13	7.6	15.2	
	9	10:35	13:10	155	0.9	13	5.0	5.5	
	11	10:54	14:55	241	1.0	88	21.9	21.9	2 earlier
	12	10:29	12:11	102	0.8	17	10.0	12.5	1 earlier
	15	9:00	12:16	116	0.9	9	4.7	5.2	
	19	10:32	11:45	133	0.3	4	1.8	6.0	Moon was full

VINCENT ANYZESKI, NEW HAVEN, CONN.

		Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
June	26	8:30	11:05	155	1.0	22	8.5	8.5	E.S.T. All plotted
	27	9:30	10:45	75	0.7	8	6.4	9.1	All plotted

MILLARD BENNETT, FORT WAYNE, INDIANA.

		Began	Ended	Min.	F.	Total	Rate	Cor.Rate	
June	3	8:00	10:13	133	1.0	13	5.9	5.9	C.S.T. asst. by Mosler
	5	8:00	11:05	185	1.0	18	5.8	5.8	Assisted by Mosler
July	9	11:14	12:07	113	0.7	12	6.4	9.1	Assisted by Welsh

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1929 September 13.

COMET NOTES.

By G. VAN BIESBROECK.

Two new comets, the second and third found this year, have been announced in the first days of August.

COMET 1929 *b* was discovered by G. Neujmin at Simeïs (Crimea) in the following position:

1929 Aug. 2.9547 U.T. $21^h\,16^m\,4^s.6$ $-12°\,45'\,41''$ (apparent).

The brightness was given as 13^M and the motion was called "planetary." The object was evidently found on plates exposed near opposition for recording asteroids as part of the regular program of the Simeïs Observatory. From the discovery position, an observation by M. Wolf in Heidelberg on August 6 and one at the Lick Observatory on August 12 by Krieger the elements I were computed at Berkeley by Bower and Willis. But the result was unsatisfactory.

ELEMENTS (1929.0) COMPUTED FOR COMET 1929 *b* (NEUJMIN).

	I	II	III
Time of Perihelion 1929 U.T.	April 16.640	July 3.57	June 28.1922
Node to Perihelion	116° 29′	144° 21′.73	140° 30′.97
Longitude of Node	154 29	157 17.64	158 13.86
Inclination	5 9	3 56.57	3 41.09
Perihelion Distance	2.1440	2.1099	2.0405
Eccentricity	1.0000	0.59710	0.58496
Period in Years	.....	11.983	10.901

A couple of days later elements II were cabled from Copenhagen; they were obtained by M. Ebell at Kiel from observation August 2 (Simeïs), 6 and 13

(Heidelberg), and show that the orbit differs strongly from a parabola. This was confirmed by the elements III due to Bower and Willis (Berkeley) and based on observations extending to September 9. This last set depending on an interval of time of seven weeks evidently comes close to the truth and the periodic character of the motion is thus well established.

The inclination being hardly 4° the orbital plane almost coincides with the ecliptic. Figure 1 shows the shape and size of the curve that the comet describes

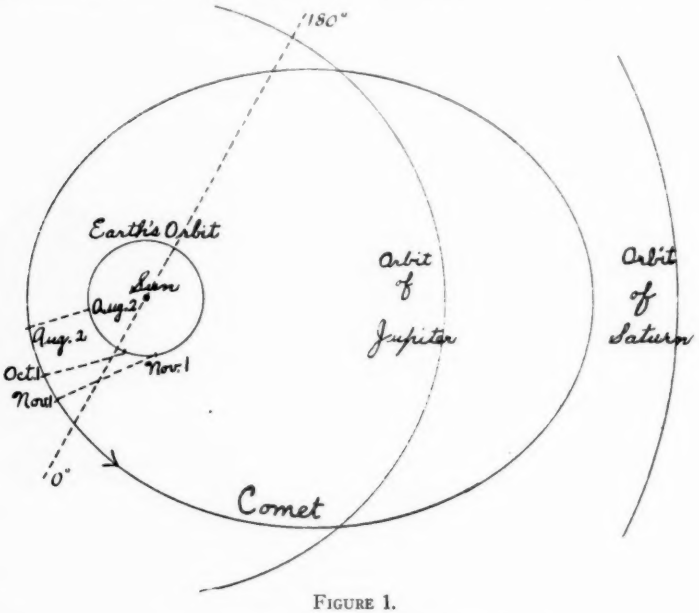


FIGURE 1.

ELLIPTIC ORBIT OF COMET 1929 *b* (NEUJMIN).

in a period of 10.9 years. When farthest from the sun the comet moves between the orbits of Jupiter and Saturn. The positions occupied by the comet and the earth respectively on August 2, October 1, and November 1 are marked so as to illustrate the present distance relations and the fact that with the increasing separation between the comet and the earth, as well as between the comet and the sun, the brightness is steadily decreasing. When first examined in the 40-inch telescope the comet had a sharp nucleus and the coma, nearly one minute of arc across, extended mostly in a southwesterly direction. The brightness on September 9 had dropped to 15M; the coma was very diffuse and there was hardly any nucleus so that the measures are now difficult even with the largest telescopes.

The following ephemeris is deduced from elements III:

1929 0h U.T.	h m s	° ′
Sept. 22	21 10 30	—15 47.5
30	14 32	49.2
Oct. 8	20 2	41.6
16	26 50	—15 25.0

COMET 1929 *c* (FORBES). From the information received concerning the third comet of the year it appears that it was first seen by Forbes in South Africa on August 1 but the discovery was not announced until the object had been seen again on August 3 when the position at 18^h U.T. was given as 20^h 0^m 52^s, —30° 26′ by the discoverer. Several weeks elapsed and nobody in the northern hemisphere located the object the brightness of which was given originally as 11^M. The next information cabled from Johannesburg August 21 was the following set of elements computed by H. E. Wood:

ELEMENTS AND EPHEMERIS OF COMET 1929 *c* (FORBES).

$$\left.\begin{aligned} T &= 1929\ \text{May}\ 26.149\ \text{U.T.} \\ \omega &= 234°\ 32' \\ \Omega &= 29\ 34 \\ i &= 5\ 27 \end{aligned}\right\} 1929.0$$

$$q = 1.5462\ \text{A.U.}$$

1929 0^h U.T.	h m s	° ′
Sept. 2	20 55 6	—27 15.2
6	56 24	26 44.5
10	58 1	26 13.3
14	20 59 55	—25 41.6

If from this orbit we compute the position for August 2 we find 20^h 53^m 40^s and —30° 26′ showing that there has been a large error in the first position transmitted, which accounts for the failure of northern observers in locating the new object. The elements are probably deduced from a short interval of observations and further observations may prove the orbit to be also elliptical, as is the case with Comet 1929 *b*. The small inclination makes this probable. On September 9 I could not find the comet near the ephemeris position which seems to indicate that an appreciable correction to the preliminary elements will be required or else that there has been a considerable drop in the brightness. Since the comet has passed nearest to the sun several months before the discovery the brightness is now diminishing. It will evidently stay too faint for ordinary instruments.

Aside from these two new objects a third comet is still under observation: COMET 1927 *d* (STEARNS) which has now been followed for two and a half years since its discovery. Its brightness is, however, between 15^M and 16^M so that only the largest instruments will show it. On September 3, when the object was measured by the writer as a small round nebulosity, the correction to the ephemeris given on page 347 of the June number was only —11^s and +0′.3, so that this prediction will hold until the object passes out of reach.

It seems as though the two periodic comets PERRINE (1896 VII) and GIACOBINI (1896 V), whose returns were expected this summer, will go by unobserved. The photographic search made here as well as in other observatories has been unsuccessful. In spite of the care taken by the computers the uncertainty of the prediction after a third of a century is apparently too great.

The circumstances are not much more favorable with COMET METCALF (1906 VI) for which the following search ephemeris, based on elements by G. Merton, has been published in the 1929 *Handbook of the British Astronomical Association*. This faint comet was followed from 1906 November 14 to 1907 January 16; from this two months' arc a period of 7.73 years resulted. But the object was not seen at the succeeding returns in 1914 and 1922. If the prediction is correct for this fall the comet is best placed for observation in October.

EPHEMERIS FOR COMET METCALF 1906 VI.

	Perihelion Nov. 19		Perihelion Nov. 27	
	R.A.	Dec.	R.A.	Dec.
0^h U.T.	h m	° ′	h m	° ′
Oct. 2	23 47.7	+2 18	23 7.3	+0 25
10	49.1	−0 26	9.1	−2 6
18	52.0	3 0	12.7	4 23
26	23 56.9	5 13	18.8	6 20
Nov. 3	0 3.8	6 58	27.3	7 49
11	12.7	8 10	38.0	8 49
19	23.6	8 49	23 50.6	9 19
27	36.0	8 58	0 4.8	9 22
Dec. 5	0 49.7	8 39	20.3	9 0
13	1 4.5	7 56	36.8	8 16
21	20.2	6 56	0 54.1	7 15
29	1 36.4	−5 40	1 12.0	−6 0

Williams Bay, Wisconsin, September 20, 1929.

VARIABLE STARS.

Monthly Report of the American Association of Variable Star Observers, for the Months of July and August, 1929.

Herewith is another almost record breaking bi-monthly report with a total of 4400 observations on 417 variables by 46 observers. We welcome several new contributors to our ranks: Messrs. Buckstaff of Oshkosh, Wisconsin, Millard of Portland, Oregon, Marsh of Frederick, Maryland, Monnig and Sanders of Fort Worth, Texas, and Zaldo of Havana, Cuba. Thus is added another country to our observational map of stations and we hope to have their continued support. Mr. Ford is back from a year spent in Europe and he now has a fine 3½-inch telescope of his own. Mr. Waterfield, from South Africa, sends in the earliest observations made on Mira, and at a time when they are most helpful for the continuity of the light curve. Mr. Logan of Dallas, Texas, has a scholarship to Columbia University which will doubtless cause a reduction in the size of his reports, but we hope to hear from him to some extent. Fortunately the Godfrey 11-inch reflector which he so well mastered at Dallas is to be sent to Fort Worth where our enthusiastic group of observing members will keep it in active use. Similarly, the Italian group of observers at Faenza, under the guidance of Sig. Lacchini, has established a splendid observing center with the installation of the A.A.V.S.O. 8-inch reflector.

The Association encourages such observing centers and it has another large reflector which it would be pleased to locate in some center of activity, once that center can be found.

With the return from vacations to observing posts we look forward to valuable contributions in the coming months. As usual, the Annual Meeting of the Association will be held at Harvard, this time on October 19. We anticipate a large attendance.

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

June 0 = J.D. 2425763; July 0 = J.D. 2425793; August 0 = J.D. 2425824.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V SCL	T CAS	Y CEP	U TUC	Y AND	o CET
000339	001755	003179	*005475*	013338	*021403*
742 13.7 Bl	804 8.3 Jo	828 9.8 Sf	734 12.9 Sm	827 11.1 Pt	813 4.2 L
775 11.9 Bl	807 8.7 Jo	829 9.5 Br	740 13.4 Bl	X CAS	820 4.2 BL
780 12.2 Dr	807 8.9 L	U CAS	757 13.5 Bl	014958	827 4.8 Sf
787 11.0 Bl	820 8.6 Jo	004047	765 14.0 Dr	707 12.1 Bn	827 5.0 Pt
799 10.5 Dr	823 8.6 Jo	770 9.6 L	780[13.8 Dr	773 11.2 Bn	834 5.1 Lg
808 9.9 Dr	826 8.8 Jo	792 8.6 L	791[13.7 Bl	781 11.1 Bn	835 5.1 Lg
S SCL	827 8.6 Pt	795 8.6 Pt	799 13.6 Dr	801 11.4 Pt	S PER
001032	R AND	796 8.8 Sf	Z CET	801 11.3 Bn	021558
742 13.2 Bl	001838	804 8.8 Sf	*010102*	806 11.4 Bn	791 9.5 Ah
771 12.5 Ht	831 11.7 Fd	807 8.4 L	770 8.8 L	810 11.4 Bn	801 9.5 Pt
775 12.1 Bl	831 12.0 Jo	809 8.7 Sf	791 9.5 L	822 11.5 Bn	827 9.0 Pt
780 11.8 Dr	833 11.8 Jo	810 8.7 Wn	801 10.0 Pt	827 12.4 Pt	831 8.5 Jo
787 11.2 Bl	834 12.0 Br	815 8.7 L	807 10.3 L	837 11.8 Bn	R CET
797 11.0 Dr	S TUC	822 9.2 Jo	827 11.5 Pt	U PER	*022000*
808 10.5 Dr	*001862*	823 9.0 Jo	U SCL	015254	810 9.8 L
X AND	732 10.1 Bl	826 9.2 Jo	*010630*	764 8.7 Ah	RR PER
001046	740 9.0 Bl	827 8.9 Pt	742 9.7 Bl	769 8.8 Ah	022150
752 9.2 Nz	750 8.4 Bl	827 9.5 Sf	775 10.2 Bl	774 9.0 Ah	772 13.1 L
770 9.2 Lj	757 8.4 Bl	834 10.0 Br	780 9.9 Dr	791 9.7 Ah	791 12.5 L
771 9.3 Lj	763 8.2 Bl	RW AND	787 10.1 Bl	801 9.7 Pt	810 11.4 L
776 9.3 Lj	771 8.2 Ht	004132	799 10.9 Dr	827 10.5 Pt	827 10.0 Pt
781 9.3 Lj	775 8.5 Bl	772[13.5 L	U AND	R ARI	U CET
788 9.5 Lj	780 8.7 Dr	807[13.7 L	010940	021024	*022813*
791 9.3 Lj	787 8.8 Bl	827 11.0 Pt	772 13.6 L	673 11.8 Wk	827 11.6 Pt
795 9.7 Lj	799 9.1 Dr	834 10.0 Br	UZ AND	801 8.3 Pt	R TRI
796 9.9 Lj	S CET	V AND	011041	823 8.7 Jo	023133
802 10.0 Lj	*001900*	004435	772 13.3 L	827 9.1 Pt	673 8.3 Wk
803 10.0 Lj	770[11.5 L	834 13.2 Br	810[13.9 L	831 8.5 Jo	790 9.0 Jo
805 10.1 Lj	T SCL	X SCL	S PSC	831 10.1 Fd	801 9.4 Jo
807 10.1 Lj	*002438a*	*004435*	011208	833 10.3 Fd	801 9.0 Pt
809 10.1 Lj	780 9.4 Dr	742 10.7 Bl	772 11.6 L	W AND	804 9.5 Jo
813 10.1 Lj	799 9.1 Dr	775 11.4 Bl	810 13.1 L	021143a	807 9.8 Jo
824 10.2 Lj	808 9.0 Dr	787 11.9 Bl	S CAS	801 9.5 Pt	809 9.5 Sf
834 10.4 Br	RR SCL	RR AND	011272	827 10.2 Pt	822 10.2 Jo
T CET	*002438b*	004533	831[13.6 Br	T PER	827 9.7 Pt
001620	780 12.9 Dr	772 12.2 L	U PSC	021258	827 10.3 Sf
772 5.7 L	799 13.0 Dr	807[12.6 L	011712	791 8.7 Ah	W PER
796 6.1 L	T PHE	835[15.0 Br	772 12.7 L	801 8.5 Pt	024356
808 6.3 L	*002546*	RV CAS	810[13.5 L	827 8.7 Pt	801 9.0 Pt
T AND	742[13.6 Bl	004746a	R SCL	831 8.6 Jo	820 9.1 Jo
001726	780 13.5 Dr	772 12.7 L	*012233a*	Z CEP	824 9.0 Jo
795 9.0 Pt	799 12.8 Dr	795 13.5 Pt	780 6.6 Dr	021281	827 9.0 Pt
801 7.8 Jo	W SCL	810 13.9 L	799 7.0 Dr	772 13.3 L	831 8.7 Jo
804 8.5 Jo	*002833*	— CAS	RZ PER	810[13.8 L	R HOR
807 8.3 Jo	742 12.9 Bl	004746b	012350	831[14.2 Br	*025050*
824 8.0 Jo	780 13.0 Dr	772 11.0 L	772 12.8 L	o CET	732 8.1 Bl
827 8.4 Pt	799 13.0 Dr	795 10.4 Pt	810 13.8 L	*021403*	740 8.5 Bl
831 9.1 Jo	Y CEP	810 11.0 L	RU AND	751 8.6 Wf	750 8.5 Bl
834 8.6 Br	003179	827 10.5 Pt	013238	773 7.3 Wf	757 8.6 Bl
T CAS	772 12.9 L	W CAS	772 12.6 L	776 7.0 Wf	763 9.0 Bl
001755	789 10.0 Sf	004958	801 13.0 Pt	781 6.7 Wf	775 9.3 Bl
673 11.9 Wk	792 10.0 L	801 11.1 Pt	810 13.0 L	794 5.5 Wf	780 9.2 Dr
770 9.3 L	795 9.7 Sf	820 11.0 Jo	827 13.0 Pt	796 4.1 BL	787 9.3 Bl
789 8.6 Jo	804 9.5 Sf	823 10.9 Jo	Y AND	801 4.5 Pt	799 10.0 Dr
791 8.7 L	807 9.4 L	826 11.2 Jo	013338	803 4.8 L	T HOR
795 8.8 Pt	815 9.2 L	827 11.0 Pt	772[13.6 L	808 3.9 BL	*025751*
801 8.3 Jo	820 9.7 Sf		810 12.6 L	809 4.8 Sf	732 11.8 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T HOR	S TAU	R DOR	R AUR	Z TAU	AG AUR
025751	042309	*043562*	050953	054615a	062047
740 12.0 Bl	831 10.9 Pt	747 5.5 Ht	801 9.0 Pt	675 10.8 Nz	772 9.3 L
780 13.2 Dr	T CAM	750 5.4 Bl	831 10.2 Pt	683 10.6 Nz	796 9.9 L
799 12.5 Dr	043065	757 5.4 Bl	T PIC	697 11.2 Nz	815 10.1 L
U ARI	734 9.7 By	763 5.5 Bl	*051247*	701 11.3 Nz	Nov PIC
030514	739 9.6 By	763 5.2 Dr	732[13.1 Bl	RV TAU	*063462*
673 12.0 Nz	743 9.3 By	766 5.4 Dr	742[12.5 Sm	054615b	734 7.5 Sm
677 11.6 Nz	751 9.3 By	768 5.5 Ht	747[13.1 Ht	675 15.3 Nz	738 7.7 En
683 11.2 Nz	753 9.1 By	773 5.5 Ht	757[12.5 Bl	683[14.7 Nz	742 7.5 Ht
699 10.4 Nz	758 9.1 By	774 5.4 Bl	790 11.0 Bl	697[13.5 Nz	745 7.8 En
813 8.3 L	761 8.8 Wk	780 5.5 Dr	T COL	699[14.7 Nz	747 7.6 Ht
X CET	768 8.9 By	786 5.5 Bl	*051533*	R COL	757 7.8 En
031401	772 8.5 L	791 5.0 Dr	732 9.6 Bl	*054629*	766 7.7 En
813 10.4 L	773 8.9 By	799 5.1 Dr	739 10.0 En	732[13.0 Bl	767 7.8 Ht
827 10.9 Pt	780 8.8 By	R CAE	740 10.0 Bl	738[12.4 En	771 7.8 Ht
Y PER	802 8.3 Be	*043738*	742 10.7 Sm	742[12.4 Sm	773 7.8 En
032043	802 8.3 L	732 11.9 Bl	742 10.7 Ht	747[13.0 Ht	777 7.5 Sm
798 9.0 Gb	813 8.1 L	740 11.8 Bl	747 10.7 Ht	757[12.4 Bl	778 7.8 Ht
801 8.3 Pt	831 8.4 Pt	742 12.0 Ht	750 10.6 Bl	U ORI	788 7.6 En
827 8.7 Pt	R RET	757 11.6 Bl	757 11.1 Bl	054920a	792 7.8 Ht
828 9.0 Gb	*043263*	763 11.5 Bl	763 11.5 Bl	831 11.6 Pt	X GEM
R PER	732 11.5 Bl	780 10.8 Dr	763 11.0 Dr	Z AUR	064030
032335	738 11.6 En	799 9.2 Dr	780 12.0 Dr	055353	703 13.2 Bn
772 10.0 L	740 11.3 Bl	R PIC	799 12.3 Dr	827 10.2 Pt	708 13.0 Bn
801 9.3 Pt	742 11.2 Sm	*044349*	S AUR	831 10.6 Pt	Y MON
813 8.9 L	742 11.4 Ht	738 9.0 En	052034	R OCT	065111
827 9.0 Pt	747 11.4 Ht	740 8.8 Bl	831 8.1 Pt	*055686*	733[12.4 GC
U ERI	750 10.7 Bl	742 8.5 Sm	S CAM	734 10.3 Sm	R LYN
034625	757 10.1 Bl	742 8.8 Ht	053068	740 10.3 Bl	065355
780 13.2 Dr	763 9.7 Bl	747 8.6 Ht	764 8.8 Ah	741 9.9 En	773 10.7 L
799 12.0 Dr	763 9.8 Dr	750 8.3 Bl	765 8.7 Wk	742 9.9 Sm	794 9.8 L
T ERI	767 9.6 Dr	757 8.0 Bl	769 8.8 Ah	743 10.2 Ht	815 9.3 L
035124	768 9.8 Ht	763 7.7 Bl	774 8.8 Ah	747 9.9 Ht	R VOL
780 12.0 Dr	773 9.4 Ht	763 7.3 Dr	831 10.3 Pt	750 9.3 Bl	*070772*
799 12.0 Dr	774 9.2 Bl	767 7.4 Dr	RR TAU	757 9.2 Bl	742[13.4 Ht
W ERI	780 8.4 Dr	774 7.6 Bl	053326	762 8.3 Dr	747 13.6 Ht
040725	786 8.5 Bl	787 7.5 Bl	673 11.5 Nz	763 8.6 Bl	763 12.8 Dr
780 12.2 Dr	791 8.0 Dr	799 6.9 Dr	674 11.7 Nz	764 8.6 En	768 13.2 Ht
799 12.5 Dr	799 7.6 Dr	T LEP	675 11.0 Nz	766 8.1 Dr	773 13.6 Ht
R TAU	X CAM	*050022*	676 11.5 Nz	771 8.8 Ht	780 11.5 Dr
042209	043274	674 9.5 Nz	677 11.0 Nz	774 8.3 Bl	788 13.0 En
673 12.8 Nz	734 12.4 By	678 9.5 Nz	683 11.6 Nz	778 8.1 Dr	791 12.3 Dr
674 13.4 Nz	739 12.5 By	697 9.9 Nz	697 11.9 Nz	778 8.8 Ht	792 13.2 Ht
677 13.5 Nz	751 13.0 By	699 10.1 Nz	699 11.7 Nz	778 9.1 Sm	801 12.4 Dr
683 13.6 Nz	758 13.0 By	732 11.0 Bl	RU AUR	788 8.7 Bl	816 11.7 Dr
697 13.7 Nz	768 12.6 By	738 11.2 En	053337	790 8.1 Dr	L_2 PUP
699 13.8 Nz	772 11.7 L	740 11.1 Bl	831[11.6 Pt	792 9.4 Ht	*071044*
831 10.4 Pt	773 11.6 By	S PIC	SU TAU	792 9.1 En	763 4.6 Dr
W TAU	780 10.9 By	*050848*	054319	797 8.6 Dr	766 4.5 Dr
042215	794 9.4 Be	732[13.4 Bl	831 9.7 Pt	799 8.8 Dr	780 4.8 Dr
831 10.8 Pt	794 9.3 L	738[12.9 En	S COL	X AUR	791 4.4 Dr
S TAU	813 7.8 L	757[12.9 Bl	*054331*	060450	797 3.8 Dr
042309	831 7.3 Pt	799[13.4 Dr	732[13.1 Bl	736 8.2 Ch	801 3.5 Dr
673 15.3 Nz	R DOR	R AUR	738[12.2 En	V AUR	816 3.1 Dr
674 15.3 Nz	*043562*	050953	742[12.4 Sm	061647	RR MON
677 15.5 Nz	738 5.6 En	764 8.1 Ah	747[12.6 Ht	767 9.2 L	071201
683 15.6 Nz	740 5.6 Bl	769 8.1 Ah	757[12.6 Bl	AG AUR	733 12.0 GC
697[14.8 Nz	742 5.2 Sm	774 8.3 Ah		062047	
699[14.8 Nz	742 5.5 Ht	791 8.8 Ah		767 9.3 L	

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

V GEM
071713
733 13.3 GC
S CMI
072708
759[11.3 Ch
Z PUP
072820b
674 14.3 Nz
675 14.4 Nz
678 14.6 Nz
682 14.7 Nz
697 14.5 Nz
699 14.4 Nz
739 11.0 En
739 11.4 Nz
743 10.8 Nz
748 10.4 Nz
758 9.3 Nz
758 8.7 En
766 8.4 En
773 8.4 En
S VOL
073173
738 9.3 En
740 9.1 Bl
742 9.4 Ht
745 9.7 En
747 9.2 Ht
750 9.3 Bl
757 9.3 Bl
759 9.6 En
762 9.4 Dr
763 9.8 Bl
766 9.6 Dr
766 9.7 En
768 9.7 Ht
773 10.0 Ht
774 10.8 Bl
777 10.5 Sm
778 10.3 Dr
786 10.9 Bl
788 11.4 En
791 11.0 Dr
792 11.1 Ht
797 11.3 Dr
801 11.9 Dr
816 12.4 Dr
U CMI
073508
759[11.2 Ch
S GEM
073723
759 10.7 Ch
763 10.8 Ch
W PUP
074241
738 12.0 En
740 11.8 Bl
742 12.2 Sm

W PUP
074241
742 12.1 Ht
745 12.0 En
747 12.3 Ht
750 12.0 Bl
757 11.1 Bl
758 11.4 En
763 10.6 Bl
766 10.4 En
766 9.9 Dr
767 10.5 Ht
771 9.9 Ht
773 9.6 En
774 9.5 Bl
777 9.4 Sm
778 9.4 Ht
780 9.4 Dr
786 9.0 Bl
789 9.2 En
791 8.7 Dw
791 8.9 Dr
792 9.0 Ht
797 8.2 Dr
801 8.0 Dr
T GEM
074323
733 8.6 GC
736 8.6 GC
759 9.0 Ch
763 9.2 Ch
R CNC
081112
673 9.4 Wk
759 7.5 Ch
V CNC
081617
759 8.9 Ch
766 8.4 L
766 8.5 Be
775 8.0 L
R CHA
082476
738 12.4 En
740 12.2 Bl
742 12.4 Ht
745 12.4 En
747 12.4 Ht
759[12.4 En
763 12.5 Bl
766[12.4 En
768 12.4 Ht
773 12.3 Ht
774 13.0 Bl
786[12.6 Bl
788[12.4 En
792[12.6 Ht
U CNC
083019
733 10.5 GC

U CNC
083019
759 11.9 Ch
768 11.9 L
S HYA
084803
745 8.0 Ch
T HYA
085008
745 9.1 Ch
771 7.8 L
T PYX
090031
732 [u Bl
763 [u Bl
790 [u Bl
V UMA
090151
766 10.3 Be
766 10.5 L
775 10.2 L
790 10.8 L
801 10.7 L
818 10.9 L
W CNC
090425
759 8.0 Ch
766 8.0 L
766 8.0 Be
775 7.8 L
781 8.3 Ty
792 9.1 Sf
RX UMA
090567
766 11.4 L
775 11.2 L
790 11.2 L
801 10.7 L
818 10.8 L
RW CAR
091868
732[13.1 Bl
742[12.8 Ht
747[12.8 Ht
759[12.8 En
763 12.6 Bl
767 12.6 Dr
768 12.8 Ht
773 12.6 Ht
774 12.4 Bl
780 12.1 Dr
786 11.8 Bl
788 12.7 En
790 11.9 Dr
791 11.8 Dw
792 12.4 Ht
797 11.7 Dr
816 9.6 Dr

Y VEL
092551
738 9.0 En
740 8.9 Bl
742 9.0 Sm
742 9.1 Ht
747 9.0 Ht
750 8.8 Bl
757 8.8 Bl
759 8.8 En
762 8.6 Dr
763 8.3 Bl
766 8.9 En
767 8.9 Dr
768 8.7 Ht
773 9.2 Ht
774 9.1 Bl
777 8.9 Sm
778 9.3 Ht
778 8.8 Dr
786 9.1 Bl
788 9.5 En
790 9.2 Dr
792 9.9 Ht
797 9.5 Dr
816 10.2 Dr
R CAR
092962
734 8.1 Sm
739 8.0 En
740 8.1 Bl
742 8.3 Sm
742 8.1 Ht
747 8.4 Ht
750 8.7 Bl
757 8.3 Bl
757 8.5 En
762 9.0 Bl
762 8.8 Dr
766 8.8 Dr
766 9.2 En
768 8.9 Ht
773 9.3 Ht
774 9.0 Bl
777 9.4 Sm
778 9.4 Ht
778 9.2 Dr
786 9.5 Bl
788 9.2 En
790 9.2 Dr
792 9.4 Ht
797 9.3 Dr
816 9.6 Dr
X HYA
093014
673 11.0 Wk
674 10.8 Nz
678 11.2 Nz
699 9.6 Nz
739 8.5 Nz

X HYA
093014
743 8.5 Nz
748 8.6 Nz
758 8.8 Nz
Y DRA
093178
673 11.6 Wk
768 14.4 L
792 13.4 L
801 12.8 L
818 13.2 L
R LMI
093934
759 6.9 Gy
760 6.8 Wk
764 6.6 Ah
769 6.7 Ah
774 6.7 Ah
788 7.0 Pt
789 7.2 Sw
790 6.8 Jo
800 7.0 Jo
804 7.5 Jo
RR HYA
094023
760 11.8 En
762 12.0 Dr
766 11.3 En
767 11.1 Dr
780 10.1 Dr
789 9.4 En
790 9.7 Dr
816 10.2 Dr
R LEO
094211
754 8.5 Sc
759 8.8 Ch
770 7.5 Be
770 7.8 An
774 7.4 Ah
774 7.2 Ch
788 7.0 Pt
791 6.8 BL
796 6.5 BL
Y HYA
094622
741 7.0 En
760 7.0 En
766 7.2 En
789 7.5 En
Z VEL
094953
732 13.3 Bl
740 13.2 Bl
763 12.7 Bl
763 12.6 Dr
766 12.6 En
767 12.5 Dr
768 12.6 Ht

Z VEL
094953
773 12.6 Ht
774 12.4 Bl
777 12.4 Sm
786 12.4 Bl
790 12.3 Dr
792 12.2 Ht
801 12.6 Dr
816 12.4 Dr
V LEO
095421
733 9.9 GC
735 10.0 GC
743 9.8 GC
743 9.8 Ch
758 10.1 GC
759 9.7 Ch
762 10.1 GC
777 10.2 Ch
788 11.1 Pt
RR CAR
095458
739 8.2 En
758 8.1 En
766 8.0 En
788 8.0 En
RV CAR
095563
739 11.6 En
740 12.0 Bl
750 12.3 Bl
762 12.7 Dr
763 13.2 Bl
767 12.9 Dr
774[13.1 Bl
791 13.6 Dr
801[13.1 Dr
S CAR
100661
739 9.0 En
740 8.5 Bl
742 9.4 Sm
742 9.4 Ht
745 8.7 En
747 8.2 Ht
750 7.9 Bl
757 7.6 Bl
757 7.5 En
762 7.3 Dr
763 7.2 Dr
763 7.5 Bl
766 7.0 Dr
766 6.7 En
768 6.9 Ht
773 6.7 Ht
774 6.8 Bl
777 6.5 Sm
778 6.6 Ht
778 6.5 Dr

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S CAR	RZ CAR	S LEO	RS CEN	SU VIR	U CEN
100661	*103270*	110506	*111661*	120012	*122854*
786 6.2 Bl	745[12.4 En	759 10.0 Ch	765 12.8 Dr	825 10.5 Bw	797 10.6 Dw
788 6.2 En	766[12.4 En	762 10.0 GC	766 13.1 En	T VIR	797 10.5 Dr
790 5.7 Dr	793 15.2 Dr	767 10.3 L	768 13.1 Ht	*120905*	816 9.2 Dr
792 6.0 Ht	793 15.0 Dw	775 10.2 L	773 13.2 Ht	768 13.2 L	T UMA
797 5.4 Dr	R UMA	782 10.3 Ch	774 13.2 Bl	788 11.7 Lg	123160
801 5.2 Dr	103769	788 10.9 Pt	786 13.5 Bl	801 11.7 Lg	673 8.5 Wk
816 5.0 Dr	673 8.4 Wk	795 11.8 L	791 13.0 Dr	R CRV	758 13.7 GC
Z CAR	759 11.2 Ch	RY CAR	792 13.1 Ht	121418	762 13.7 GC
101058a	765 11.7 Wk	*111561*	797 12.3 Dr	678 8.1 Nz	788 12.8 Lg
732[12.6 Bl	777 11.7 Ch	734 10.3 Sm	816 10.1 Dr	692 8.7 Nz	788 13.0 Pt
734[12.3 Sm	788 12.0 Pt	735 10.0 Sm	X CEN	701 9.1 Nz	801 12.5 Lg
742[12.3 Ht	822 12.1 Pt	735 10.4 Ht	*114441*	739 11.0 Nz	820 11.7 Jo
747[12.3 Ht	V HYA	736 10.2 Sm	740 12.6 Bl	743 11.4 Nz	822 11.5 Pt
763[12.6 Bl	*104620*	736 10.5 Ht	763 13.5 Bl	748 11.6 Nz	823 11.5 Jo
768[12.3 Ht	740 7.6 Bl	738 10.3 En	765 13.2 Dr	758 11.6 Nz	826 10.8 Jo
773[12.6 Ht	750 6.9 Bl	739 10.5 En	797 13.9 Dw	768 11.7 L	828 10.0 Ma
777[12.3 Sm	757 7.5 Bl	740 10.9 Bl	797 13.8 Dr	775 11.9 L	829 10.4 Hs
789[12.3 En	763 7.7 Bl	740 10.7 En	AD CEN	788 13.3 Pt	839 9.4 Ma
790[12.6 Bl	768 7.6 L	741 10.8 En	*114858*	SS VIR	R VIR
792[12.6 Ht	774 7.9 Bl	742 10.5 Sm	738 9.3 En	*122001*	123307
793[14.0 Dw	786 7.6 Bl	742 10.8 Ht	742 9.5 Ht	768 8.5 L	782 11.5 Ch
797[15.0 Dw	RS HYA	743 10.9 En	744 9.3 En	770 8.2 Be	788 10.6 Pt
797 15.2 Dr	*104628*	744 11.2 En	747 9.6 Ht	770 9.2 An	790 10.8 Sw
AF CAR	740 10.8 Bl	747 11.2 Ht	759 9.3 En	775 8.2 L	792 10.8 Ch
101058b	750 11.1 Bl	750 11.0 Bl	768 9.5 Ht	790 7.9 L	822 7.6 Pt
793 12.3 Dw	757 11.2 Bl	757 11.6 En	773 9.7 Ht	802 7.9 Be	RS UMA
793 12.2 Dr	763 11.5 Bl	757 11.7 Bl	778 9.4 Ht	802 7.8 L	123459
797 12.5 Dw	774 11.8 Bl	759 11.6 En	778 9.5 Sm	813 8.0 L	678 14.5 Nz
797 12.1 Dr	786 12.2 Bl	762 12.7 Dr	789 9.2 En	T CVN	686 14.7 Nz
W VEL	W LEO	763 12.2 Bl	792 9.3 Ht	122532	692 14.7 Nz
101153	104814	763 12.0 En	W CEN	782 11.6 Ch	739 12.1 Nz
734 9.5 Sm	678 13.8 Nz	765 12.8 Dr	*115058*	788 12.1 Pt	759 9.7 Nz
738 9.6 En	686 13.7 Nz	766 12.1 En	738 12.2 En	789 12.3 BL	765 8.6 Wk
740 9.3 Bl	739 13.2 Nz	768 12.5 Ht	740 12.4 Bl	791 12.1 BL	777 8.6 Ch
742 10.0 Ht	758 12.4 Nz	773 12.9 Ht	742 12.5 Ht	796 12.2 BL	788 8.5 Lg
747 10.2 Ht	759 12.3 Ch	774 12.6 Bl	747 12.6 Ht	822 11.3 Pt	788 8.4 Pt
750 9.7 Bl	766 12.0 L	786 13.3 Bl	763 13.2 Bl	Y VIR	789 8.3 Jo
757 9.9 Bl	766 12.2 Be	791 13.2 Dr	765 13.2 Dr	*122803*	790 8.3 Ch
759 10.0 En	777 10.9 L	792 13.1 Ht	768[12.6 Ht	678 11.1 Nz	800 8.4 Jo
763 9.8 Bl	780 10.2 Ch	797 13.2 Dr	773[12.6 Ht	686 10.2 Nz	801 8.5 Lg
765 9.7 Dr	788 8.8 Pt	RS CEN	778 13.0 Dr	692 10.0 Nz	804 8.5 Jo
766 10.7 En	792 9.4 Sf	*111661*	791 12.5 Dr	701 9.4 Nz	807 8.9 Jo
768 10.5 Ht	795 9.3 Sf	734 9.8 Sm	792 12.4 Ht	739 9.8 Nz	809 9.0 Wd
773 10.8 Ht	795 9.2 Be	735 10.2 Ht	816 10.0 Dr	739 10.2 GC	820 9.0 Jo
774 10.6 Bl	795 9.2 L	738 10.5 En	R COM	743 10.2 Nz	822 10.2 Pt
777 10.8 Sm	RS CAR	740 10.6 En	115919	743 10.1 GC	823 9.5 Jo
778 10.3 Dr	*110361*	740 10.4 Bl	765 9.6 Wk	748 10.2 Nz	826 9.9 Jo
786 10.6 Bl	734[12.3 Sm	742 10.5 Sm	784 9.7 BL	758 10.3 Nz	828 10.0 Ma
789 11.0 En	742[12.3 Sm	742 10.6 Ht	788 10.6 Lg	758 11.4 GC	839 11.5 Ma
791 10.6 Dr	766[12.3 En	744 11.2 En	788 10.8 Pt	762 11.4 GC	S UMA
792 10.8 Ht	777[12.3 Sm	747 11.2 Ht	789 10.2 BL	768 11.6 L	123961
801 11.1 Dr	S LEO	750 11.4 Bl	791 10.7 BL	801 12.6 Lg	673 8.4 Wk
U HYA	110506	757 12.2 Bl	796 10.8 BL	U CEN	742 10.7 Ch
103212	733 11.0 GC	757 12.1 En	SU VIR	*122854*	758 12.1 GC
766 5.4 Be	736 11.0 GC	759 12.2 En	120012	740 13.0 Bl	762 12.0 GC
766 5.5 L	739 10.8 GC	762 12.7 Dr	788 12.3 Lg	763 13.0 Bl	765 11.0 Wk
773 5.2 L	743 10.8 GC	763 12.7 En	788 12.6 Pt	774 13.0 Bl	769 11.3 Ah
773 6.0 Kd	758 10.0 GC	763 12.8 Bl	795 12.3 Bw	790 11.6 Bl	770 10.9 Be

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S UMA	RU VIR	R HYA	RV CEN	T CEN	RX CEN
123961	124204	*132422*	*133155*	*133633*	*134536*
770 11.3 Lj	788 13.0 Pt	738 9.6 En	765 8.4 Dr	816 6.7 Dr	765 12.2 Dr
770 10.9 An	790 13.0 L	740 9.4 Bl	765 8.0 Dr	820 7.2 Kd	774 12.7 Bl
771 11.2 Lj	795 13.0 Bw	742 10.1 Sm	774 8.5 Bl	RT CEN	778 12.6 Dr
774 10.9 Lj	825 13.0 Bw	743 10.0 Ht	787 7.8 Bl	*134236*	790 13.0 Bl
774 10.9 Ah	U VIR	746 9.4 Ch	791 8.1 Dr	738 9.6 En	791 12.9 Dr
775 10.8 Ah	124606	748 10.1 Ht	T UMI	740 9.3 Bl	T APS
776 10.6 Lj	739 8.1 Ch	750 9.3 Bl	133273	742 9.4 Sm	*134677*
777 10.3 Ch	764 9.2 Ah	757 9.4 Bl	765 10.1 Wk	743 9.6 Ht	732 11.0 Bl
780 10.4 Lj	768 9.4 L	760 9.6 En	771 10.2 L	745 9.6 En	740 11.5 Bl
781 10.4 Lj	769 9.2 Ah	763 9.4 Bl	776 9.1 Sf	748 9.6 Ht	740 11.7 En
788 10.2 Lj	774 9.4 Ah	767 10.1 Ht	789 8.8 Sf	750 9.5 Bl	742 12.0 Sm
788 9.7 Pt	788 10.1 Pt	768 9.6 L	790 8.4 L	757 9.4 Bl	743 11.6 Ht
788 10.1 Lg	790 10.3 L	771 9.9 Ht	795 8.9 Sf	760 10.0 En	750 12.4 Bl
789 9.6 Jo	808 11.6 L	774 9.2 Bl	801 8.6 L	762 9.6 Dr	762 12.9 Dr
790 9.8 Ch	RV VIR	774 9.5 En	804 9.0 Sf	763 10.1 Bl	763 12.8 Bl
791 9.2 Ah	*130212*	782 9.5 Ch	805 9.1 BL	767 10.5 Dr	768 13.2 Ht
791 9.7 Lj	740 13.0 GC	787 9.0 Bl	808 9.2 BL	767 10.4 Ht	773 13.2 Ht
796 8.5 Ch	762 14.2 GC	788 9.2 Pt	808 9.1 Sf	771 10.8 Ht	774 13.1 Bl
796 9.5 Lj	768 14.1 L	789 9.0 En	809 9.2 BL	774 10.9 Bl	780 13.3 Dr
797 8.8 Wd	796[13.8 Bw	792 9.5 Ht	813 8.8 L	774 10.8 En	793 13.9 Dw
798 8.8 Gt	U OCT	794 9.2 L	816 9.4 BL	778 10.2 Dr	793 14.0 Dr
798 8.7 An	*131283*	794 9.4 An	817 9.4 BL	787 11.0 Bl	RR VIR
798 8.7 Be	732 12.9 Bl	796 9.4 Ch	820 9.6 BL	789 11.4 En	*135908*
799 8.7 Wd	740 12.4 En	S VIR	820 9.1 Sf	791 11.6 Dr	788 11.8 Pt
800 9.0 Jo	740 12.0 Bl	*132706*	823 9.0 Jo	R CVN	Z BOO
801 9.1 Lg	742 12.2 Sm	735 9.0 Ht	828 9.6 Sf	134440	140113
802 9.3 Lj	742 11.9 Ht	738 8.7 En	830 9.8 Br	759 7.9 Gy	771 14.5 L
804 8.7 Jo	747 11.8 Ht	739 8.8 Hs	T CEN	764 8.0 Ah	802[14.0 L
805 8.9 Lj	750 11.7 Bl	739 8.9 Ch	*133633*	765 8.0 Wk	810 14.1 Wn
806 8.6 Ah	757 11.3 Bl	742 8.8 Ch	735 7.6 Ht	769 7.9 Ah	816 14.0 L
807 8.6 Ah	759 11.2 En	742 8.4 Sm	738 7.4 En	774 8.0 Ah	824 14.2 Wn
807 9.0 Lj	762 11.1 Dr	743 8.6 Ht	740 7.1 Bl	775 8.1 Ah	830[12.7 Ty
807 8.9 Jo	763 11.2 Bl	748 7.8 Ht	742 7.2 Sm	781 8.2 Ah	Z VIR
809 8.5 Wd	765 11.2 En	757 8.0 En	743 7.3 Ht	781 7.9 Ty	*140512*
809 8.5 Gt	767 11.1 Dr	767 6.8 Ht	745 7.1 En	788 8.3 Pt	771 13.4 L
809 8.8 Lj	774 10.9 Bl	771 6.5 Ht	748 6.8 Ht	789 8.3 Sw	794[14.3 L
813 8.7 Lj	778 10.9 Dr	771 6.8 Sp	750 6.3 Bl	791 8.4 Ah	RU HYA
816 8.4 Ah	778 11.0 Ht	774 6.7 En	757 6.0 Bl	792 8.4 Sc	*140528*
817 8.3 An	778 10.9 Sm	778 6.6 Ht	758 6.2 En	797 8.6 Ch	732 13.5 Bl
820 8.5 Jo	787 10.2 Bl	782 7.0 Ch	762 6.0 Dr	805 8.8 BL	738[12.5 En
822 8.0 Pt	791 10.3 Dr	786 6.6 Lg	763 6.0 Bl	806 8.3 Ty	740 13.7 Bl
823 8.2 Jo	791 10.3 En	786 6.6 Mo	765 6.0 Dr	808 8.6 BL	748[12.9 Ht
824 8.3 Wd	792 10.2 Ht	788 6.7 Pt	767 6.1 Ht	808 8.7 Sw	760[12.5 En
824 8.5 Lj	797 10.0 Dr	789 6.9 Sc	771 5.9 Ht	808 8.8 Ah	763[13.5 Bl
826 8.0 Jo	W VIR	789 6.8 En	772 6.3 Kd	809 8.8 BL	767[12.9 Ht
828 8.0 Ma	*132002*	790 6.9 Sw	773 6.1 Kd	811 8.5 Ty	771[13.5 Ht
839 8.0 Wd	788 10.0 Lg	792 7.0 Ht	774 6.3 En	816 9.0 BL	774[12.5 En
839 7.7 Ma	800 9.5 Lg	796 7.3 Ch	774 6.2 Bl	817 8.6 BL	789[12.5 En
RU VIR	825 10.3 Lg	801 7.3 Sp	778 6.1 Dr	820 9.4 BL	790[13.5 Bl
124204	V VIR	822 8.4 Pt	778 6.2 Ht	822 9.1 Pt	797 14.1 Dw
733 12.4 GC	*132202*	824 8.2 Sp	780 6.1 Dr	823 9.0 Gy	797 13.9 Dr
735 12.4 GC	768 9.1 L	826 8.4 Hs	787 6.3 Bl	830 9.3 Ty	R CEN
736 12.4 GC	771 9.5 Sp	RV CEN	789 6.4 Kd	RX CEN	*140059*
739 12.4 GC	788 9.8 Lg	*133155*	789 6.5 En	*134536*	732 6.9 Bl
743 12.5 GC	790 10.0 L	740 8.3 Bl	791 6.3 Dr	740 11.1 Bl	738 7.1 En
758 12.7 GC	800 10.4 Lg	750 7.8 Bl	791 6.7 Ht	750 11.5 Bl	740 6.9 Bl
762 12.6 GC	825 10.6 Lg	757 7.9 Bl	797 6.7 En	757 11.8 Bl	742 6.4 Sm
768 12.7 L		763 8.4 Bl	805 7.2 Kd	763 12.0 Bl	742 7.0 Ht

VARIABLE STAR OBSERVATIONS RECEIVED DURING JULY AND AUGUST, 1929.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R CEN			S BOO			R BOO			Y LUP			Y LIB			RU LIB		
140959			141954			143227			*145254*			*150605*			*152714*		
747	7.0	Ht	798	10.4	Gb	770	8.6	Lj	790[	13.7	Bl	813	9.5	L	771	8.6	L
750	7.0	Bl	801	9.7	Jo	771	8.6	Lj	793	14.3	Dw	822	10.1	Pt	788	9.7	Pt
757	7.2	Bl	802	11.1	L	774	8.7	Lj	793	14.3	Dr	S LIB			794	9.3	L
757	7.3	En	803	10.7	Be	774	8.3	Ah	S APS			*151520*			815	10.9	L
762	7.3	Dr	804	10.0	Jo	775	8.8	Ah	*145971*			771	11.1	L	819	11.7	An
763	7.6	Bl	807	10.9	Jo	776	8.7	Lj	732	12.9	Bl	788	12.0	Pt	822	11.8	Pt
768	7.5	Ht	816	12.0	L	778	9.0	Ch	734	12.5	Sm	794	12.2	L	R NOR		
773	7.6	Ht	819	11.8	An	779	9.2	Lj	735	13.4	Ht	816	11.4	L	*152849*		
774	7.9	Bl	820	11.8	Jo	780	9.4	Lj	738	12.5	En	822	12.7	Pt	733	7.6	Bl
774	7.5	En	822	11.9	Pt	781	9.1	Ah	740	12.5	En	S SER			735	7.8	Ht
778	7.5	Ht	RS VIR			788	9.9	Lj	740	12.4	Bl	151714			738	7.9	En
778	7.4	Dr	142205			788	9.8	Pt	742	12.5	Sm	736[	13.0	Ch	740	7.7	Bl
787	7.4	Bl	678	11.8	Nz	789	9.1	Wd	743	13.2	Ht	763	13.0	Ch	742	7.8	Sm
789	7.6	En	686	11.6	Nz	790	10.6	Jo	743	12.5	En	771	12.7	L	743	8.0	Ht
790	7.8	Bl	692	12.1	Nz	791	10.0	Lj	750	12.2	Bl	786	11.3	Lg	748	8.7	Ht
791	7.8	Dr	701	12.2	Nz	791	9.9	Ah	757	12.2	Bl	786	11.5	Mo	750	8.0	Bl
792	8.0	Ht	736	13.4	Nz	792	9.6	Wd	757	12.2	En	790	13.1	L	757	8.5	Bl
797	7.9	Dr	739	13.7	Nz	794	10.0	Ch	762	12.4	Dr	800	11.3	Lg	760	9.0	En
816	7.7	Dr	759	14.1	Nz	796	10.4	Lj	763	12.0	En	802	12.9	L	762	8.6	Dr
U UMI			771	13.8	L	797	10.3	Wd	763	12.2	Bl	810	12.7	Wn	763	8.7	Bl
141567			790	14.2	L	798	9.6	Sw	765	12.0	Dr	818	12.7	L	768	8.9	Ht
764	8.9	Ah	816[	13.7	L	801	11.0	Jo	768	12.2	Ht	822	12.6	Pt	773	9.1	Ht
765	9.8	Wk	V BOO			802	10.7	Lj	773	12.5	Ht	825	11.0	Lg	774	9.0	Bl
769	8.7	Ah	142539a			803	10.7	Lj	773	12.0	En	852	10.9	Ml	774	9.0	En
770	9.1	Lj	764	8.1	Ah	805	10.8	Lj	774	12.2	Bl	S CRB			777	9.0	Sm
771	9.1	Lj	769	8.1	Ah	807	11.2	Lj	777	12.2	Sm	151731			778	9.1	Ht
774	9.0	Lj	774	8.1	Ah	809	11.7	Lj	778	12.1	Dr	736	12.0	Ch	778	9.0	Dr
774	8.7	Ah	775	8.1	Ah	813	11.9	Lj	780	11.9	Dr	778	12.4	Ch	787	8.9	Bl
775	8.8	Ah	781	8.1	Ah	822	11.8	Pt	787	12.1	Bl	788	12.3	Pt	789	9.9	En
776	8.9	Lj	788	8.2	Pt	824	12.4	Lj	789	11.2	En	792	12.4	Ch	791	9.3	Dr
780	8.8	Lj	789	8.2	Jo	826	12.0	Jo	790	12.0	Bl	822	12.2	Pt	792	9.9	Ht
788	8.7	Lj	791	8.6	Ah	831	11.5	Sw	791	11.1	Dr	RS LIB			797	9.3	Dr
788	8.1	Pt	794	8.5	Ch	V LIB			792	12.0	Ht	*151822*			X LIB		
791	8.8	Lj	798	8.8	An	*143417*			793	11.7	Dr	732	11.3	Bl	*153020*		
791	8.7	Ah	800	8.7	Jo	771	13.5	L	793	11.8	Dw	734	11.5	Sm	733[	12.9	Bl
796	8.5	Lj	802	9.0	Gt	794	13.5	L	797	11.3	Dr	735	11.6	Ht	764	12.6	Bl
802	8.5	Lj	804	8.7	Jo	830[	12.0	Ty	801	11.9	Dr	739	11.2	En	775	11.5	Bl
804	8.4	Gb	804	8.9	Gb	S LUP			816	11.7	Dr	740	11.3	Bl	787	11.0	Bl
805	8.6	Lj	806	8.7	Ah	*144646a*			RT LIB			742	11.4	Sm	W LIB		
807	8.6	Lj	807	8.8	Jo	744	10.5	En	*150018*			743	11.2	Ht	*153215*		
808	8.8	Ah	808	8.9	Ah	775	11.4	En	799[	12.5	Wn	748	11.3	Ht	733	11.3	Bl
809	8.5	Lj	819	9.2	An	790	12.1	En	829	12.0	Lg	750	10.5	Bl	740	11.3	Bl
813	8.5	Lj	820	9.2	Jo	U BOO			830	12.7	Ty	757	10.0	Bl	743	11.5	Ch
822	8.0	Pt	821	9.6	Sf	144918			T LIB			760	10.3	En	750	11.8	Bl
824	8.6	Jo	822	9.2	Pt	788	10.8	Lg	*150519*			763	10.0	Bl	771	12.9	L
824	8.3	Lj	826	9.4	Jo	801	11.5	Bw	759[	12.4	Ch	767	10.0	Ht	764	12.5	Bl
826	8.4	Jo	828	9.7	Sf	818	11.6	Bw	793[	13.0	Ch	771	9.8	Ht	775[	13.0	Bl
828	8.2	Gs	831	10.0	Fd	830	11.6	Bw	811[	13.0	Wn	771	9.9	L	780[	12.5	Dr
833	8.5	Jo	R CAM			Y LUP			829[	13.5	Lg	774	9.4	Bl	790[	13.4	Bl
S BOO			142584			*145254*			Y LIB			774	10.0	En	793[	13.4	Ch
141954			735	9.6	By	732[	13.7	Bl	*150605*			777	9.7	Sm	794	14.0	L
772	9.1	L	739	10.1	By	738[	13.4	En	771	11.2	L	778	9.5	Ht	S UMI		
788	9.9	Ch	825[	13.5	Br	760[	13.9	En	788	9.8	Pt	787	8.6	Bl	153378		
788	10.0	Pt	R BOO			763[	13.7	Bl	788	9.5	Lg	789	8.9	En	736	11.0	Ch
789	9.0	Jo	143227			774[	13.7	En	790	9.5	L	792	8.3	Ht	770	10.3	Lj
790	10.2	L	745	7.5	Ch	778[	12.4	Sm	794	9.6	L	794	8.3	L	771	10.2	Lj
790	10.0	Ch	764	8.3	Ah	789[	13.7	En	799	9.1	Wn	813	8.3	L	774	10.1	Lj
795	10.0	Sw	769	8.6	Ah				801	10.0	Lg	819	8.1	An	776	10.0	Lj

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S UMi	R CrB	R CrB	R CrB	R CrB	V CrB
153378	154428	154428	154428	154428	154639
779 9.9 Ch	736 6.1 Ch	789 5.8 Jo	804 6.2 Lj	823 6.0 Gb	825 8.0 Lg
780 10.1 Lj	739 6.1 Ch	789 6.1 Lj	805 6.2 Lj	824 6.1 Pt	828 7.7 Bw
783 9.7 Ch	743 6.1 Ch	789 6.2 Lg	805 6.1 Pt	824 6.1 Lg	836 7.4 Md
786 9.3 Mo	759 6.0 Gy	789 5.7 Sw	805 6.2 Kd	824 6.2 Lj	852 7.6 Ml
786 9.2 Lg	762 6.2 Km	789 5.9 Kd	806 6.1 Pt	824 5.8 Hs	R Lib
788 9.6 Lj	763 6.1 Ch	790 6.1 Lg	806 6.3 Lj	824 6.0 Sp	*154715*
788 8.8 Pt	764 6.2 Ah	790 6.0 Jo	806 6.2 Lj	824 5.8 Wd	743 12.4 Ch
789 9.6 Lj	764 6.0 Km	790 6.0 L	806 6.0 Ah	825 6.1 Lg	771 13.5 L
791 9.5 Lj	765 6.0 Be	790 6.2 Ch	807 6.2 Kd	826 6.0 Lg	778[12.4 Ch
796 9.6 Lj	765 6.0 L	791 6.1 Lj	807 5.8 Jo	826 6.1 Pt	793[13.5 Ch
797 9.7 Ch	767 6.0 L	791 6.2 Lg	807 6.2 Lj	826 5.7 Hs	830[12.5 Ty
801 9.0 Mo	769 6.0 Ah	791 6.1 Pt	808 6.2 Lj	826 5.8 Jo	R Lup
801 9.0 Sd	769 6.0 Be	791 6.0 Ah	808 6.1 Pt	827 6.0 Lg	*154736*
802 9.4 Lj	770 6.2 Lj	791 6.0 L	808 6.1 Lg	827 6.1 Pt	738 9.7 En
805 9.4 Lj	770 6.0 An	791 5.9 Kd	808 5.9 Sw	828 6.1 Pt	760 9.8 En
807 9.4 Lj	771 6.0 Sp	792 6.0 Lg	808 6.0 Be	828 6.4 Gs	765 10.0 Dr
809 9.3 Lj	771 6.1 Lj	792 6.0 Wd	809 6.1 Kd	829 5.8 Hs	774 10.2 En
813 9.1 Lj	771 6.0 L	793 6.0 Be	809 6.1 Pt	829 5.9 Lg	778 10.3 Dr
822 8.5 Pt	771 6.2 Kd	793 6.1 Lg	809 6.2 Lj	830 6.1 Pt	790 11.3 En
823 8.7 Gy	772 6.2 Kd	793 6.0 Kd	810 6.2 Lg	831 6.1 Pt	791 11.0 Dr
823 8.7 Sf	772 6.0 L	794 6.1 Ch	810 6.1 Pt	831 6.0 Fd	RR Lib
823 8.0 Jo	772 6.1 Km	794 6.0 L	810 6.2 Lj	831 6.1 Sw	*155018*
824 8.7 Lj	773 6.1 Km	794 6.1 Lg	811 6.1 Pt	831 5.8 Hs	765 8.1 Dr
826 8.4 Jo	773 6.2 Kd	794 6.1 Gt	812 6.1 Pt	833 5.9 Lg	771 8.5 L
833 9.0 Jo	773 6.1 Gy	794 5.9 An	813 6.0 L	834 5.8 Lg	771 8.5 Sp
U Lib	774 6.1 Lj	795 5.8 Sw	813 6.2 Lj	834 5.7 Hs	778 8.2 Dr
153620a	774 6.0 Ah	795 6.1 Pt	813 6.1 Wd	836 6.1 Pt	788 9.0 Pt
733 10.0 Bl	774 5.9 L	795 6.1 Wd	814 6.1 Pt	839 5.7 Hs	791 8.8 Dr
741 9.9 Bl	775 6.1 Lj	795 6.0 L	814 6.0 Hs	839 6.2 Wd	794 9.2 L
750 9.5 Bl	775 6.0 Ah	795 6.0 Be	815 6.0 Kd	X CrB	795 9.3 Bw
757 9.6 Bl	776 6.1 Lj	796 6.0 L	815 6.1 Pt	154536	797 9.2 Dr
764 10.5 Bl	776 6.0 L	796 6.1 Lg	815 6.0 L	736[12.2 Ch	815 10.4 L
765 10.1 Dr	777 6.0 Be	796 6.2 Lj	815 6.2 Lj	771 12.7 L	822 11.5 Pt
775 10.9 Bl	777 6.0 L	797 6.2 Lg	816 6.0 L	778 12.2 Ch	824 10.9 Sp
778 10.5 Dr	778 6.1 Pt	797 6.1 Wd	816 6.0 Ch	788 10.8 Pt	825 11.9 Bw
787 11.2 Bl	779 6.2 Ch	797 6.0 Ch	816 6.0 Ah	790 11.0 L	Z CrB
791 11.5 Dr	779 6.1 Lj	798 6.0 Gb	816 6.1 Wd	802 10.6 L	155229
T Nor	779 5.9 Km	800 6.0 Lg	817 6.1 Gt	810 9.8 Wn	734 11.6 By
153654	779 6.1 Kd	800 6.0 Wd	817 6.0 Kd	815 10.0 L	736 11.8 Ch
735 10.5 Ht	780 6.1 Lj	801 6.1 Mo	817 6.1 Pt	822 9.6 Pt	739 11.6 By
738 10.9 En	780 6.2 Pt	801 6.1 Sd	818 6.0 Lg	824 9.9 Wn	742 11.7 By
742 10.9 Sm	781 6.2 Pt	801 6.0 Sp	818 6.1 Pt	R Ser	751 11.9 By
743 11.6 Ht	781 6.1 Lj	801 6.0 Lg	818 6.0 L	154615	757 12.2 By
748 11.8 Ht	781 6.1 Ah	801 6.1 An	819 6.1 Pt	736 12.1 Ch	758 12.3 By
760 12.0 En	781 6.0 Wd	801 6.0 Be	819 6.2 Lg	777[12.1 Ch	762 12.6 By
765 12.1 Dr	781 6.1 Kd	801 6.0 Gy	819 6.2 Kd	830[12.0 Md	771 12.8 L
768 12.8 Ht	782 6.2 Ch	801 6.0 Kd	819 6.0 Gy	846[11.3 Md	778[12.4 Ch
773 13.1 Ht	782 6.1 Pt	801 6.2 Pt	819 5.9 An	V CrB	788 12.8 Lg
774 12.8 En	783 6.1 Pt	802 6.1 Gt	820 6.0 Hs	154639	800 13.0 Lg
780 13.2 Dr	783 6.0 L	802 6.0 L	820 6.0 Jo	764 9.8 Ah	802 13.6 L
791 13.5 Dr	784 6.1 Pt	802 6.2 Lj	820 6.1 Lg	788 8.5 Pt	810 14.2 Wn
792 13.1 Ht	786 6.0 Be	803 6.2 Lj	820 6.1 Pt	788 9.0 Lg	824 14.7 Wn
Z Lib	786 5.9 Lg	803 6.0 Lg	821 6.1 Lg	801 8.3 Lg	825[13.5 Lg
154020	788 6.1 Lg	803 6.0 Mo	821 6.1 Pt	805 9.0 BL	833[12.4 Md
733[12.7 Bl	788 6.2 Lj	803 6.1 Sd	822 6.1 Pt	808 8.6 BL	848[12.4 Ml
764[13.0 Bl	788 6.1 Pt	803 6.0 Be	822 5.8 Jo	820 8.5 BL	RZ Sco
790[13.3 Bl	789 6.1 Pt	804 5.8 Jo	822 6.0 Sp	822 7.9 Bw	*155823*
	789 6.1 Wd	804 6.0 Lg	823 6.1 Pt	822 7.2 Pt	735 11.5 Ht

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RZ Sco			X Sco			RU Her			W CrB			SS Her			W Her		
155823			*160221a*			160625a			161138			162807			163137		
737	11.4	En	750	12.0	Bl	736[	12.9	Ch	823	9.6	Pt	789	9.1	Pt	807	8.8	Jo
742	11.5	Sm	764	12.6	Bl	771	13.7	L	831	9.3	Jo	790	8.8	L	820	10.7	Jo
743	11.5	Ht	795[	13.0	Bl	778	13 0	Ch	833	9.6	Md	799	9.1	Wn	823	13.3	Pt
748	11.5	Ht	SX Her			790	13.4	L	848	9.8	Ml	802	9.0	L	851[	12.0	Jo
760	11.2	En	160325			802	13.2	L	W Oph			817	11.6	L	R Dra		
767	10.4	Ht	734	9.1	By	818	13.2	L	*161607*			823	12.0	Pt	163266		
771	9.9	Ht	735	8.8	By	822	13.2	Pt	771	10.6	L	824	12.2	Wn	736	11.6	Ch
774	9.5	En	739	9.1	By	R Sco			782	10.6	Ty	T Oph			764	10.5	Ah
777	9.3	Sm	742	8.9	By	*161122a*			786	10.5	Mo	*162815*			769	10.3	Ah
778	9.3	Ht	751	9.1	By	678	11.2	Nz	786	10.7	Lg	733	10.2	Bl	770	10 9	Lj
789	9.6	Pt	753	9.2	By	686	11.4	Nz	789	11.1	Pt	741	10 5	Bl	771	10.8	Lj
790	9.2	En	754	9.1	By	692	11.5	Nz	790	11.1	L	750	10.8	Bl	774	10.8	Lj
792	9.4	Ht	757	9.1	By	701	11.8	Nz	800	10.8	Lg	758	11.1	Bl	774	10.0	Ah
796	9.4	Sc	758	9.0	By	733	13.0	Bl	802	11.4	L	764	11.5	Bl	776	10.4	Lj
805	8.9	Sc	762	8.6	By	735[	12.6	Ht	804	11.3	Sw	765	11.6	Dr	779	10.3	Ch
822	8.6	Pt	768	8.1	By	736	14.0	Nz	806	11.0	Ty	771	11.8	L	780	10.4	Lj
Z Sco			771	7.9	L	741[	13.0	Bl	811	11.0	Ty	775	11.5	Bl	781	10.3	Lj
160021			773	8.1	By	743	14.4	Nz	816	12.0	L	780	11.7	Dr	788	9.7	Lj
735[	12.0	Ht	774	8.1	By	759[	14.2	Nz	823	11.7	Pt	787	11.7	Bl	789	9.4	Pt
737[	12.2	En	778	8.0	Pt	764[	13.2	Bl	825	11.7	Lg	795	11.9	Bw	790	9.1	Ch
743[	12.0	Ht	780	8.0	Pt	767[	12.6	Ht	830	11.4	Ty	795	11.9	L	791	9.3	Lj
764	11.8	Bl	780	8.1	By	771[	12.6	Ht	V Oph			797	12.4	Dr	791	9.1	Ah
767	11.8	Ht	781	8.1	Pt	774[	12.6	En	*162112*			799[	12.0	Wn	792	9.3	Wd
771	11.6	Ht	782	7.8	Pt	790[	12.6	En	771	8.1	L	808	12.3	Wn	795	9.1	Wd
771	11.5	L	783	7.9	Pt	790[	12.0	Bl	781	8.3	Ch	817	12.6	L	796	8.9	Lj
774	11.2	En	784	8.0	Pt	S Sco			789	8.6	Pt	825	12.8	Bw	797	8.5	Ch
775	11.4	Bl	784	8.1	By	*161122b*			794	9.3	L	830[	12.0	Ty	797	8.7	Wd
777	10.9	An	788	8.0	Pt	678	13.4	Nz	816	8.9	L	S Oph			799	8.5	Wd
777	11.5	Be	789	7.9	Pt	686	13.6	Nz	823	8.9	Pt	*162816*			800	8.8	Jo
777	11.2	Sm	790	7.9	L	692	13.8	Nz	U Her			733	12.3	Bl	801	8.7	Jo
778	11.5	Ht	791	8.0	Pt	701[	13.6	Nz	162119			741[	13.2	Bl	802	8.5	Lj
787	10.7	Bl	795	8.0	Pt	733	13.2	Bl	759	12.0	Ch	764[	12.6	Bl	804	8.3	Jo
790	10.7	En	801	8.0	Pt	735[	12.6	Ht	777	11.8	Ch	771	14.1	L	805	8.2	Lj
792	11.1	Ht	802	7.7	L	736	13.8	Nz	789	11.4	Pt	790[	13.2	Bl	807	8.1	Lj
795	10.9	Gt	805	8.0	Pt	737[	12.2	En	790	10.5	Jo	817[	13.8	L	807	8.3	Jo
795	10.7	L	809	8.4	Pt	741	12.8	Bl	804	10.2	Jo	823[	13.3	Bw	808	7.9	Ah
795	10.6	Be	810	8.4	Pt	742[	12.4	Sm	807	9.9	Jo	830[	12.7	Ty	808	8.0	Ma
798	10.1	An	811	8.2	Pt	743	13.2	Nz	820	9.9	Jo	W Her			808	8.1	Gy
802	10.8	Gt	812	8.2	Pt	759	12.2	Nz	823	10.4	Pt	163137			809	8.0	Lj
816	10.4	L	814	8.2	Pt	763	12.0	En	823	10.4	Sf	734	8.6	By	813	7.9	Lj
819	10.5	An	815	8.2	Pt	764	11.8	Bl	824	9.7	Jo	735	8.7	By	820	8.0	Jo
R Her			815	7.9	L	767	11.5	Ht	829	10.4	Hs	736	8.7	Ch	822	7.9	Ma
160118			817	8.0	Pt	771	10.8	Ht	831	10.0	Fd	739	8.9	By	823	8.0	Gy
782	10.2	Ty	818	8.0	Pt	773	10.5	Ht	833	10.8	Sw	742	9.0	By	823	8.0	Pt
789	10.7	Pt	821	8.2	Pt	774	11.5	En	839	10.3	Hs	743	9.1	By	824	7.8	Lj
806	11.6	Ty	822	8.2	Pt	775	11.4	Bl	Y Sco			751	9.8	By	824	8.0	Hs
830[	12.4	Ty	823	8.2	Pt	777	10.8	Sm	*162319*			753	10.0	By	824	8.0	Wd
U Ser			824	8.3	Pt	778	10.2	Ht	771	11.3	L	754	10.0	By	824	7.8	Jo
160210			827	8.5	Pt	787	10.1	Bl	795	12.5	Gt	757	10.2	By	824	8.0	Br
789	13.5	Pt	828	8.4	Pt	789	10.0	Pt	795	12.5	Be	758	10.2	By	829	8.2	Hs
808[	11.4	Ma	830	8.5	Pt	790	9.4	Bl	795	11.6	Bw	762	10.3	By	830	7.8	Br
819	12.5	An	831	8.5	Pt	790	10.2	En	795	12.5	L	768	10.8	By	831	8.1	Hs
822	12.7	Pt	W Sco			792	9.2	Ht	802	12.6	Gt	773	11.1	By	834	8.1	Hs
839	11.5	Ma	*160519*			823	11.3	Pt	817	13.3	L	774	11.4	By	839	8.1	Hs
X Sco			733[	13.0	Bl	W CrB			830	12.3	Bw	777	10.8	Ch	839	8.0	Ma
160221a			734[	13.0	Dr	161138			SS Her			789	11.8	Pt	840	8.1	Wd
733	11.5	Bl	764[	13.0	Bl	789	11.6	Pt	162807			800	8.8	Jo			
741	11.6	Bl	790[	13.0	Bl	822	9.2	Sp	771	9.3	L	804	9.0	Jo			

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RR OPH	RR SCO	R OPH	RS HER	SV SCO	RY HER
164319	*165030a*	*170215*	171723	*174135*	175519
678 10.2 Nz	750 11.8 Bl	774 9.4 L	801 9.5 Bw	733 9.3 Bl	759 10.4 Ch
686 10.3 Nz	758 11.6 Bl	789 8.3 Sc	808 9.1 Wn	741 9.1 Bl	768 11.0 L
692 10.5 Nz	762 11.7 En	789 8.0 Pt	822 8.3 Bw	742 9.5 En	779 11.6 Ch
701 10.9 Nz	764 11.8 Bl	790 7.8 Jo	824 8.4 Wn	750 9.4 Bl	789 13.0 Pt
736 12.8 Nz	765 12.0 Dr	792 8.4 Sc	827 8.3 Pt	760 10.4 En	793 12.5 Ch
743 13.3 Nz	768 11.9 Ht	795 7.6 L	828 7.3 Bw	764 9.6 Bl	795 13.0 L
774 14.0 L	773 11.8 Ht	796 8.4 Sc	837 8.3 Md	765 9.8 Dr	804 13.4 Bw
789 13.6 Pt	774 11.5 En	801 8.0 Jo	852 8.9 Ml	775 9.8 Bl	823 13.7 Bw
795 14.5 L	775 11.6 Bl	801 8.3 Sw	S OCT	775 10.1 En	824 13.6 Bk
817[14.0 L	777 11.1 Sm	804 8.2 Jo	*172486*	780 10.3 Dr	827 13.5 Pt
823 13.3 Pt	780 11.2 Dr	807 8.0 Jo	733 9.3 Bl	787 10.7 Bl	V DRA
S HER	787 10.6 Bl	817 7.0 Gt	740 9.6 En	790 11.0 En	175654
164715	790 11.0 En	817 7.6 L	741 9.6 Bl	791 10.6 Dr	768 10.3 L
764 10.4 Ah	791 10.6 Dw	820 8.4 Jo	742 9.8 Sm	W PAV	780 9.8 Ch
774 10.0 Ah	792 11.0 Ht	821 7.2 Bk	742 10.0 Ht	*174162*	793 9.5 Ch
781 9.6 Ch	801 10.0 Lg	821 7.2 Bk	747 10.2 Ht	733 11.7 Bl	799 9.7 Br
789 9.5 Pt	808 8.9 Dr	823 8.4 Jo	750 9.6 Bl	735 12.5 Ht	802 10.0 L
791 9.4 Ah	829 9.3 Lg	823 8.4 Jo	758 9.8 Bl	741 12.6 Bl	816 10.1 L
807 8.5 Ah	SS OPH	827 8.0 Pt	759 10.0 En	743 12.8 Ht	827 10.6 Pt
820 7.6 Jo	*165202*	831 8.2 Jo	764 10.1 Bl	764[13.0 Bl	851 11.8 Ml
826 7.5 Jo	789 8.2 Pt	842 8.4 Bk	765 10.4 En	765 13.5 Dr	R PAV
827 7.6 Pt	827 11.7 Pt	RT HER	765 9.9 Dr	768[13.0 Ht	*180363*
RS SCO	829 11.5 Md	170627	771 10.8 Ht	773[13.0 Ht	735 10.3 Ht
164844	846 12.2 Md	736 9.8 Ch	775 10.8 Bl	790[13.0 Bl	737 10.5 En
733 11.7 Bl	RV HER	768 11.6 L	778 11.1 Dr	792[13.0 Ht	742 11.1 Sm
735 11.8 Ht	165631	781 12.3 Ch	778 10.9 Ht	797 14.2 Dw	743 10.7 Ht
741 11.4 Bl	736[12.7 Ch	788[13.2 Lg	787 11.7 Bl	797 14.0 Dr	765 12.4 Dr
742 11.7 Sm	774 14.3 L	792 13.0 Br	791 12.2 En	RS OPH	768 12.3 Ht
743 11.8 Ht	794 13.7 L	794 12.9 L	792 12.3 Ht	174406	773 12.5 Ht
750 11.2 Bl	798 13.8 Bw	812[12.1 Ty	RU OPH	789 11.1 Pt	797 13.6 Dw
758 10.9 Bl	817 12.6 An	828[12.0 Bk	172809	827 11.1 Pt	797 13.7 Dr
760 11.2 En	817 12.8 L	RW SCO	768 13.1 L	U ARA	T HER
764 10.9 Bl	818 12.5 Bw	*170833*	789 13.6 Pt	*174551*	180531
765 10.6 Dr	827 11.4 Pt	733[13.0 Bl	795 14.0 L	743[13.0 Ht	759 12.6 Ch
768 10.8 Ht	830 11.4 Bw	764[12.6 Bl	817 12.8 L	765[13.4 Dr	768 13.5 L
773 11.0 Ht	831 11.0 Md	765[13.2 Dr	819 12.5 An	771[13.0 Ht	779 12.6 Ch
774 10.7 Bl	846 10.5 Md	780[13.1 Dr	840 10.9 Md	797 13.7 Dw	789 12.4 Pt
774 10.4 En	RT SCO	790[13.0 Bl	RT SER	797 14.0 Dr	793 11.7 Ch
777 10.4 Sm	*165636*	790[13.0 Dr	*173212*	RT OPH	801 10.3 Sw
778 9.9 Dr	733[13.5 Bl	Z OPH	774 12.3 L	175111	802 10.8 L
778 10.6 Ht	743 11.0 En	171401	795 12.3 L	768[13.4 L	808 10.2 Ah
787 9.8 Bl	763[12.1 En	771 11.3 Sp	818 12.5 L	798 13.9 Bw	816 9.2 L
790 9.6 En	764 12.3 Bl	786 10.2 Mo	RU SCO	800 13.1 Lg	822 9.3 Bk
791 8.9 Dr	765 11.9 Dr	786 10.1 Lg	*173543*	808 14.7 Wn	823 9.0 Jo
792 9.1 Ht	774 10.2 En	789 10.4 Pt	733 11.7 Bl	812[11.8 Ty	827 8.8 Pt
801 7.9 Mo	775 10.1 Bl	800 8.7 Lg	741 11.6 Bl	822[13.9 Bw	829 8.8 Hs
801 8.0 Sd	780 9.0 Dr	801 9.5 Sp	742 11.8 En	824 15.0 Wn	831 9.0 Hs
803 8.0 Sd	787 8.6 Bl	822 8.4 Sp	750 11.0 Bl	831[13.9 Bw	831 8.7 Fd
803 7.9 Mo	790 8.4 En	823 8.2 Bk	758 11.5 Bl	T DRA	831 8.7 Jo
808 7.3 Dr	791 8.3 Dw	825 8.0 Lg	762 11.0 En	175458a	834 8.7 Hs
RR SCO	791 8.3 Dr	827 7.6 Pt	764 11.0 Bl	780 12.1 Ch	835 8.7 Bk
165030a	808 7.6 Dr	828 8.2 Bk	765 11.1 Dr	833 11.8 Lg	836 8.7 Bk
733 11.5 Bl	— DRA	RS HER	775 11.2 Bl	UY DRA	837 8.7 Bk
735 11.9 Ht	165752	171723	775 11.0 En	175458b	839 8.5 Hs
737 11.4 En	768 12.9 L	786 9.7 Mo	780 10.7 Dr	780 11.0 Ch	842 8.1 Bk
741 11.8 Bl	794 12.0 L	786 9.7 Lg	787 10.9 Bl	833 10.9 Lg	847 8.2 Bk
742 11.7 Sm	816 11.8 L	786 9.7 Lg	790 10.5 En		
743 12.2 Ht		789 9.4 Pt	791 10.3 Dr		

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
W DRA			W LYR			X OPH			R SCT			R SCT			R SCT		
180565			181136			183308			*184205*			*184205*			*184205*		
768	13.7	L	831	9.6	Sw	804	6.9	Jo	789	5.5	Jo	806	5.6	Gb	825	5.9	Lg
789	12.4	Pt	837	9.8	Bk	807	6.8	Jo	789	5.9	Wd	806	5.4	Lj	826	6.1	Lg
802	9.8	L	RV SGR			818	6.8	L	789	5.7	Kd	806	5.5	Pt	827	6.1	Bk
816	9.4	L	*182133*			819	6.8	An	789	5.9	Sw	807	5.4	Kd	827	6.2	Lg
827	9.1	Pt	742	9.4	Bl	820	6.9	Jo	790	5.7	Lg	807	5.5	Jo	827	5.9	Pt
852	9.0	Ml	750	9.2	Bl	823	6.5	Jo	790	5.4	L	807	5.4	Lj	828	6.1	Bk
X DRA			764	8.5	Bl	827	6.6	Pt	791	5.6	Lj	808	6.1	Ma	828	6.1	Gs
180666			765	8.2	Dr	831	6.6	Jo	791	5.9	Pt	808	5.5	Be	828	5.9	Pt
768[	14.0	L	775	8.3	Bl	844	6.5	Bk	791	5.5	Kd	808	5.4	Sw	829	6.3	Lg
802[	14.0	L	778	7.8	Dr	RS DRA			792	5.7	Lg	808	5.4	Kd	830	6.1	Pt
816[	13.0	L	787	7.8	Bl	184074			792	6.0	Wd	808	5.2	Lg	831	6.0	Jo
NOV OPH			791	7.7	Dr	734	10.1	By	792	5.2	Sc	808	5.5	Lj	831	6.1	Pt
180911			792	7.4	Lg	739	10.1	By	793	5.7	Ch	808	5.5	Pt	831	5.9	Fd
789[	13.0	Pt	799	7.7	Dr	758	10.1	By	793	5.8	Lg	809	5.8	Wl	833	6.5	Lg
TV HER			808	7.8	Dr	762	10.2	By	793	5.5	Kd	809	5.8	Gb	834	6.2	Pt
181031			825	7.9	Lg	774	10.1	By	794	5.6	Lg	809	5.4	Kd	834	6.1	Bk
768	9.9	L	833	8.2	Lg	RV LYR			794	5.8	Pt	809	5.6	Lj	834	6.5	Lg
802	10.6	L	SV HER			184134			795	5.4	Mo	809	5.4	Pt	836	6.3	Bk
816	11.7	L	182224			773	11.2	L	795	5.7	Fd	810	5.4	Pt	837	6.3	Bk
RY OPH			773	11.9	Lg	780	10.4	Ch	795	5.7	Sw	810	5.5	L	838	6.7	Bk
181103			789	10.5	Pt	790	10.0	Jo	795	5.8	Pt	810	5.4	Lg	859	7.1	Wd
774	11.0	Ah	792	10.7	Br	791	10.1	Pt	795	5.9	Wd	810	5.5	Lj	840	6.9	Ma
789	9.4	Pt	798	11.1	Bw	792	10.2	Br	795	5.5	Fd	811	5.4	Pt	841	5.7	Bk
791	9.4	Ah	803	9.8	L	793	10.4	Ch	796	5.6	Lj	813	5.8	Gb	842	6.7	Bk
807	8.4	Ah	816	10.1	L	803	10.6	L	796	5.7	Lg	813	5.6	Lj	843	6.7	Bk
808	8.4	Ah	824	10.7	Bw	804	10.3	Jo	796	5.4	Sc	814	5.3	Pt	844	6.7	Bk
827	9.6	Pt	827	10.3	Pt	818	11.2	L	796	5.2	L	815	5.2	Pt	847	7.1	Bk
829	9.8	Md	T SER			827	11.6	Pt	797	5.6	Ch	816	5.4	Kd	848	7.0	Bk
839	11.0	Md	182306			R SCT			**797**	5.9	Lg	816	5.8	Wd	849	7.1	Bk
W LYR			804	12.2	Ty	*184205*			797	5.9	Wd	817	6.0	Gb	853	8.0	Bk
181136			810	12.2	Wn	759	5.8	Gy	798	5.2	Gb	817	5.5	An	854	8.0	Bk
764	8.5	Ah	819	12.2	Wn	770	5.8	An	798	5.5	An	817	5.4	Kd	855	8.0	Bk
768	8.2	L	824	12.1	Wn	771	6.0	Sp	798	5.1	Be	817	5.5	Pt	NOV AQL		
769	8.5	Ah	824	11.5	Sp	771	6.0	Lj	800	5.1	Lg	817	5.6	L	184300		
774	8.4	Ah	824	11.9	Bw	771	5.8	L	800	5.8	Wd	818	5.7	Lg	771	11.2	Sp
775	8.4	Ah	825	12.0	Lg	771	5.6	Kd	801	5.6	Mo	818	5.7	Pt	778	11.7	Pt
781	8.5	Ah	827	11.2	Pt	772	5.5	Kd	801	5.6	Sd	819	5.4	Kd	788	11.7	Pt
781	8.3	Wd	829	10.8	Ty	773	5.6	Gy	801	5.5	Sp	819	5.7	Lg	790	10.6	Ch
789	8.3	Jo	SV DRA			774	6.0	Lj	801	5.0	Lg	819	5.7	An	791	11.7	Pt
789	8.1	Pt	183149			775	5.9	Lj	801	5.5	Jo	819	5.6	Gy	792	10.9	Lg
789	8.3	Wd	773	11.7	L	776	6.0	Lj	801	5.8	Pt	820	6.1	Bk	795	11.7	Pt
791	8.6	Ah	792	10.3	Br	778	6.0	Pt	801	5.3	Gb	820	6.2	Kd	801	10.6	Lg
792	8.5	Wd	803	10.9	L	779	5.7	Ch	801	5.6	An	820	5.4	Kd	801	11.1	Sp
795	8.6	Wd	822	11.4	Ma	779	6.0	Lj	801	5.2	Be	821	6.1	Bk	801	11.7	Pt
795	8.2	Sw	839	11.6	Ma	779	5.6	Kd	802	5.6	Gb	821	5.8	Lg	805	11.7	Pt
797	8.8	Wd	RZ HER			780	5.9	Lj	802	5.2	Be	821	5.7	Pt	818	11.8	Pt
800	8.8	Wd	183225			780	5.8	Pt	802	5.5	Lj	822	6.1	Bk	821	11.9	Pt
801	8.2	Jo	768	10.1	L	781	5.9	Lj	803	5.2	L	822	5.9	Sp	822	10.5	Ma
802	8.4	L	792	11.0	Br	781	5.9	Pt	803	5.2	Lg	822	5.5	Kd	824	11.2	Sp
808	8.6	Ah	803	11.5	L	781	5.9	Wd	803	5.5	Lj	822	5.7	Pt	825	10.8	Lg
809	8.0	Wd	X OPH			782	5.8	Pt	803	5.6	Mo	823	6.1	Bk	833	10.7	Lg
816	8.8	L	183308			783	5.9	Pt	803	5.9	Sd	823	5.5	Kd	839	10.6	Ma
820	8.7	Jo	763	7.7	L	784	5.8	Pt	804	6.0	Gb	823	6.0	Jo	849	10.3	Bk
823	8.9	Sf	789	7.1	Jo	786	5.8	Mo	804	5.3	Lg	824	5.9	Lj	RX LYR		
824	9.8	Bk	789	7.5	Pt	786	5.7	Lj	805	5.3	Sc	824	5.8	Lg	185032		
824	8.9	Jo	796	7.5	Sc	**788**	5.7	Lg	805	5.4	Kd	824	5.8	Pt	743	12.8	Ch
827	9.2	Pt	801	7.3	Jo	789	5.6	Ch	805	5.5	Lj	824	6.0	Sp	780[	13.0	Ch
831	9.5	Jo	803	6.9	L	789	5.8	Lg	805	5.6	Pt	824	6.1	Kd	792[	14.1	Br

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RX LYR	V LYR	RS LYR	RY SGR	S SGR	R CYG
185032	190529a	190933a	*191033*	*191310a*	193449
803[13.0 L	773 11.7 L	804 10.9 Bw	771 6.5 Ht	808[12.9 L	789 8.4 Wd
S CRA	780 11.0 Ch	824 11.3 Bw	772 6.7 L	SW SGR	791 8.1 Ah
185437a	791 10.1 Pt	827 11.5 Pt	773 6.3 En	*191331*	791 8.0 Pt
742 11.9 Bl	792 10.5 Br	RU LYR	775 6.0 Bl	742[12.9 Bl	792 8.3 Wd
764 11.5 Bl	793 10.4 Ch	190941	777 6.5 Sm	775[12.9 Bl	792 8.6 Sc
775 12.1 Bl	803 10.6 L	781[13.3 Ch	778 6.3 Pt	790[12.9 Bl	795 8.5 Wd
790 12.1 Bl	810 10.5 Wn	793[13.3 Ch	778 6.7 Dr	TZ CYG	797 8.4 Wd
ST SGR	824 10.0 Wn	799[14.0 Br	778 6.5 Ht	191350	799 9.0 Br
185512a	827 10.2 Pt	801[13.2 Lg	780 6.8 Dr	791 9.9 Pt	800 8.4 Wd
772 12.5 L	RX SGR	833[14.0 Br	781 6.5 Pt	822 11.0 Sp	800 8.2 Jo
803 10.5 L	*190818*	U DRA	787 6.3 Bl	827 11.0 Pt	803 7.4 Gy
818 9.2 L	773 9.9 En	190967	788 6.3 Pt	U LYR	804 8.3 Jo
825 9.3 Lg	791 9.6 Pt	773[13.2 L	789 6.4 Pt	191637	807 8.3 Jo
829 9.2 Lg	791 9.6 En	791 14.0 Pt	790 6.7 L	791 9.5 Pt	808 8.0 Ch
833 9.2 Lg	804 9.7 Ty	793 13.7 Ch	790 6.5 Ch	827 11.1 Pt	808 8.3 Ah
R CRA	804 10.0 Bw	805 13.8 L	791 6.4 Pt	AF CYG	809 8.3 Wd
185537a	812 9.7 Ty	810 13.8 Wn	791 6.7 Dr	192745	816 8.4 Wd
742 13.5 Bl	823 10.3 Bw	825 13.2 Br	791 6.5 En	764 7.0 Ah	820 8.4 Jo
764[12.5 Bl	825 10.9 Lg	827 13.8 Pt	792 6.5 Ht	769 7.2 Ah	823 8.6 Pt
790 12.5 Bl	827 10.7 Pt	W AQL	795 6.3 Pt	774 7.2 Ah	824 8.4 Jo
T CRA	RW SGR	*191007*	797 6.3 Dw	775 6.9 Ah	824 8.4 Wd
185537b	*190819a*	791 10.6 Pt	799 6.2 Dr	781 7.1 Ah	828 9.2 Gs
742 13.5 Bl	773 10.2 En	804 9.7 Bw	801 6.4 Pt	791 7.0 Ah	831 8.9 Sw
764[12.5 Bl	791 10.1 Pt	810 8.9 Wn	801 6.7 Sd	808 7.0 Ah	835 9.6 Bk
790 13.5 Bl	791 10.2 En	823 9.1 Bw	801 6.7 Mo	TY CYG	840 8.9 Wd
Z LYR	804 10.3 Bw	827 8.5 Pt	801 6.2 Dr	192928	853 9.7 Bk
185634	804 9.8 Ty	833 8.5 Lg	801 6.4 L	743 10.4 Ch	RV AQL
773[14.0 L	812 9.8 Ty	T SGR	802 6.6 Sd	773 10.0 L	193509
793[13.0 Ch	823 10.1 Bw	*191017*	803 6.6 Mo	779 9.6 Ch	767 10.9 L
799 13.8 Br	825 9.8 Lg	773 12.3 L	805 6.3 Pt	790 10.0 Ch	791 9.8 Pt
SU SGR	TY AQL	781 12.4 Ch	808 6.3 L	791 9.8 Pt	792 9.5 Lg
185722	*190907*	791 12.4 Pt	808 6.3 Dr	799 10.3 Br	792 9.5 Sc
771 8.4 Ht	791 10.3 Pt	808 12.4 L	813 6.3 L	801 10.3 Sp	796 9.6 Sc
778 8.8 Ht	804 10.4 Bw	827 12.4 Pt	815 6.3 Pt	807 10.5 L	803 9.1 L
RT LYR	810 10.9 Wn	834 13.0 Bk	816 6.3 L	808 10.8 Ch	805 9.6 Sc
185737	823 10.4 Bw	R SGR	816 6.4 Dr	827 11.6 Pt	818 9.2 L
743 10.0 Ch	827 10.6 Pt	*191019*	818 6.6 Pt	RT AQL	823 10.0 Pt
773 11.0 L	833 10.5 Lg	773 12.4 L	821 6.6 Pt	193311	829 10.0 Lg
780 12.2 Ch	S LYR	791 12.2 Pt	824 7.1 Gt	773 14.5 L	832 10.5 Br
793 12.4 Ch	190925	806 11.0 Za	827 6.5 Pt	792 13.4 Lg	T PAV
799 12.9 Br	793[13.3 Ch	807 11.5 Za	831 6.6 Pt	808 13.4 L	*193072*
804 13.5 L	799[13.8 Br	807 12.4 Ch	TY SGR	827 13.1 Pt	734 7.7 Sm
810 13.3 Wn	810 14.1 Wn	808 12.0 L	*191124*	832 13.0 Br	735 7.7 Ht
R AQL	824 13.0 Wn	819 11.2 Za	742 10.0 Bl	R CYG	742 7.3 Bl
190108	833 12.8 Br	824 11.4 Sp	765 10.4 Dr	193449	743 7.3 Ht
764 8.1 Ah	X LYR	827 11.5 Pt	773 10.7 En	753 8.0 Ch	748 7.6 Ht
769 8.3 Ah	190926	RY SGR	775 10.9 Bl	759 7.3 Ch	751 7.2 Bl
774 8.7 Ah	791 9.0 Pt	*191033*	778 11.2 Dr	764 7.4 Ah	764 8.2 Bl
775 8.8 Ah	827 9.2 Pt	742 6.0 Bl	787 11.4 Bl	769 7.4 Ah	765 7.6 Dr
780 8.0 Ch	RS LYR	742 6.3 En	791 11.5 En	774 7.5 Ah	771 8.1 Ht
791 9.2 Ah	190933a	743 6.5 Ht	791 11.5 Dr	775 7.6 Ah	775 8.2 Bl
796 9.4 Ch	773 11.1 L	754 6.3 En	799 11.7 Dr	778 7.1 Ch	777 8.6 Sm
806 9.0 Za	781 11.2 Ch	762 6.2 Dr	S SGR	781 7.6 Ah	778 8.3 Ht
819 10.1 Za	791 11.0 Pt	763 6.3 En	*191310a*	781 8.2 Wd	778 8.4 Dr
827 11.0 Pt	793 10.9 Ch	764 6.3 Bl	742 10.5 Bl	789 8.0 Ch	787 8.6 Bl
	799 9.4 Br	765 6.1 Dr	775 13.3 Bl	789 7.7 Jo	791 9.3 Dr
	803 11.0 L	767 6.3 L	775 12.9 L	789 8.2 Sw	791 9.2 En

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T PAV	χ CYG	S PAV	Z CYG	S AQL	RS CYG
193972	194632	*194659*	195849	200715a	200938
792 9.2 Ht	790 5.3 Ah	780 7.1 Dr	790 8.6 Ch	734 11.1 By	791 7.6 Pt
799 9.6 Dr	790 5.2 Ch	791 6.8 Dr	791 8.3 Pt	739 11.1 By	792 8.4 Sc
808 10.3 Dr	790 5.2 Sw	791 7.6 En	792 8.6 Sc	742 11.2 By	796 8.1 Sc
RT CYG	790 5.1 Wd	799 7.0 Dr	795 8.5 Ch	751 11.1 By	797 7.2 Wd
194048	791 5.2 Pt	RR SGR	796 8.2 Sc	753 11.1 By	800 7.4 Wd
764 7.3 Ah	791 5.2 Ah	*194929*	803 8.4 L	759 11.1 By	801 7.5 Jo
769 7.4 Ah	791 6.0 Kd	742 5.4 Bl	805 8.3 Sc	768 10.9 By	803 7.8 Sd
774 7.5 Ah	792 5.0 Ch	765 6.2 Dr	808 8.4 Ch	773 10.8 By	803 7.8 Mo
775 7.4 Ah	792 5.2 Wd	775 6.4 Bl	823 8.0 Pt	774 10.8 By	803 7.5 L
778 7.0 Ch	792 5.0 Sc	780 6.8 Dr	833 8.2 Br	780 10.4 By	804 7.5 Jo
781 7.7 Ah	793 5.9 Kd	787 7.2 Bl	838 9.6 Bk	787 9.4 Ch	809 7.4 Wd
789 7.5 Ch	794 5.8 Kd	791 7.0 Dr	S TEL	791 9.4 Pt	820 7.4 Jo
789 7.8 Jo	794 5.1 Ch	799 7.3 Dr	*195855*	792 9.1 Lg	822 7.4 Sp
789 7.8 Sw	795 5.0 Wd	808 8.0 Dr	742 12.6 Bl	797 9.3 Ch	823 7.1 Pt
791 8.0 Ah	796 5.3 Ch	RU SGR	771 12.8 Ht	823 9.1 Pt	824 7.2 Wd
791 8.0 Pt	797 5.3 Wd	*195142*	775 12.8 Bl	RW AQL	826 7.3 Hs
801 8.2 Jo	799 5.3 Br	742 12.5 Bl	790 13.0 Bl	200715b	826 7.3 Jo
804 8.3 Jo	800 5.3 Wd	743 12.5 Ht	SY AQL	826 7.3 Jo	831 7.2 Jo
806 5.7 Ah	800 5.5 Jo	764 11.4 Bl	200212	791 9.2 Pt	840 7.2 Hs
807 5.5 Ah	801 5.1 Sp	765 11.1 Dr	767 14.3 L	792 9.3 Lg	R DEL
807 8.4 Jo	801 5.6 Gt	771 11.4 Ht	775 14.5 L	823 9.3 Pt	201008
808 5.5 Ah	801 5.5 An	773 11.3 En	808[14.3 L	R TEL	764 8.7 Ah
808 8.6 Ch	802 5.5 Ch	775 10.9 Bl	810 13.9 Wn	*200747*	766 8.4 L
816 5.5 Ah	804 5.7 Jo	777 10.5 Sm	819[13.2 Br	742[13.5 Bl	774 8.2 Ah
820 8.3 Jo	805 5.9 Kd	778 10.9 Ht	823 13.2 Pt	765[13.6 Dr	775 8.1 Ah
823 9.5 Pt	805 5.4 Sc	780 9.8 Dr	834[13.2 Br	775[13.5 Bl	775 7.9 L
824 8.4 Jo	807 5.6 Jo	787 9.5 Bl	BU CYG	790[13.5 Bl	791 7.8 Pt
831 9.6 Sw	809 5.9 Kd	791 9.7 En	200250	RU AQL	791 7.9 Ah
TU CYG	809 5.3 Wd	791 9.1 Dr	771[12.7 Lj	200812	807 8.1 L
194348	811 5.9 Kd	792 9.1 Ht	791 12.8 Lj	775 12.4 L	808 8.5 Ah
743 12.4 Ch	813 5.3 Wd	799 8.0 Dr	796 12.7 Lj	808 13.4 L	817 8.5 Br
774 14.1 L	815 5.9 Kd	RR AQL	802 12.0 Lj	817 13.2 Br	822 9.0 Sp
799 14.3 Br	816 5.6 Wd	*195202*	803 12.0 Lj	828 13.5 Br	823 9.4 Pt
834 12.8 Br	816 5.9 Kd	767[14.0 L	805 12.1 Lj	829[13.5 Lg	RT CAP
X AQL	816 5.5 Ch	834 9.1 Bk	807 12.0 Lj	W CAP	*201121*
194604	817 6.0 Kd	RS AQL	809 12.0 Lj	*200822*	791 6.6 Pt
775[14.4 L	819 6.2 Kd	195308	813 11.9 Lj	742 11.7 Bl	805 7.2 Kd
832 13.6 Br	820 6.2 Kd	767 9.9 L	824 11.7 Lj	775 11.8 Bl	820 7.1 Kd
χ CYG	820 5.3 Ma	775 9.8 L	S CYG	790 13.0 Bl	822 7.1 Kd
194632	822 6.1 Kd	803 10.5 L	200357	Z AQL	823 6.3 Pt
743 7.2 Ch	822 5.7 Jo	833 10.9 Lg	767 12.5 L	200906	SX CYG
754 6.1 Sc	823 6.1 Kd	NOV CYG	775 13.0 L	686 13.9 Nz	201130
759 5.8 Ch	823 5.5 Pt	195553	781 13.3 Ch	692 14.2 Nz	791 13.6 Pt
764 5.4 Ah	824 6.1 Kd	778[12.2 Pt	791 13.9 Pt	701[13.8 Nz	810 14.5 Wn
769 5.2 Ah	824 5.5 Sp	791[12.2 Pt	799 14.5 Br	736 9.3 Nz	823 13.7 Pt
771 5.1 Sp	824 5.4 Wd	801[12.2 Pt	812[12.3 Ty	743 9.2 Nz	824[13.9 Bw
771 5.7 Kd	826 5.4 Jo	818[12.2 Pt	834[14.3 Br	752 8.8 Nz	828[13.9 Br
772 5.7 Kd	828 6.8 Gs	821[12.2 Pt	R CAP	791 13.2 Pt	RT SGR
773 5.7 Kd	831 5.8 Sw	RR TEL	*200514*	801 13.5 Bw	*201139*
774 5.0 Ah	836 6.1 Bk	*195656*	775 14.0 L	823 13.0 Pt	742 13.0 Bl
775 5.0 Ah	839 6.1 Wd	743[12.6 Ht	791 13.5 Pt	824 13.3 Bw	775 12.5 Bl
778 5.1 Ch	839 7.0 Ma	771[12.6 Ht	810 13.2 Wn	RS CYG	787 11.7 Bl
781 5.1 Ah	840 6.2 Hs	Z CYG	823 12.9 Pt	200938	WX CYG
781 5.6 Kd	842 5.8 Bk	195849	SV CYG	754 8.6 Sc	201437b
783 5.0 Ch	S PAV	767 9.1 L	200647	766 7.8 L	766 9.1 L
789 5.8 Jo	*194659*	775 8.4 L	789 9.4 Sc	771 7.8 Sp	775 9.6 L
789 4.9 Sc	765 7.2 Dr	781 8.9 Ch		775 7.8 L	790 10.2 Jo
789 5.8 K-1	773 7.6 En	789 8.4 Sc		790 7.8 Jo	791 9.6 Pt
				790 7.0 Wd	

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
WX CYG	Z DEL	V CYG	T AQR	TW CYG	T CEP
201437b	202817	203847	*204405*	*210129*	210868
801 11.2 Jo	766[13.9 L	806 9.8 L	831 8.7 Jo	765 13.5 L	781 9.4 Ah
803 10.9 L	775 13.7 L	821 10.0 Sf	RZ CYG	776 12.9 L	789 8.3 Jo
804 11.4 Jo	799 12.7 Br	823 9.0 Pt	204846	804 12.6 L	789 9.0 Ch
822 11.8 Sp	804 12.4 L	828 9.8 Sf	795 12.2 Pt	806 11.8 Br	790 9.1 Wd
823 12.0 Pt	834 11.0 Br	840 8.8 Ma	806 12.0 Br	808 11.8 Ch	790 9.0 Sw
U CYG	ST CYG	Y AQR	823 12.9 Pt	810 11.3 Wn	791 9.0 Ah
201647	202954	*203005*	834 12.7 Br	824 10.9 Sp	792 9.3 Wd
780 8.0 Ch	775 10.7 L	686 14.4 Nz	S IND	830 10.5 Br	795 8.2 Pt
781 8.4 Wd	791 11.0 Pt	701[13.5 Nz	*204954*	X CAP	795 9.5 Ah
789 8.0 Ch	806 9.7 Br	736[14.7 Nz	742[13.5 Bl	*210221*	797 8.8 Wd
789 9.0 Wd	806 9.6 L	743[14.7 Nz	765 11.4 Dr	742[12.7 Bl	799 8.9 Wd
789 8.2 Jo	808 10.1 Ch	752 14.7 Nz	771 10.8 Ht	775[12.7 Bl	801 8.3 Jo
790 8.9 Wd	823 9.8 Pt	T DEL	775 9.6 Bl	X CEP	801 9.2 Gy
791 8.1 Pt	829 10.0 Br	204016	778 9.8 Ht	210382	802 9.0 Ch
792 8.9 Wd	V VUL	765 11.6 L	780 8.8 Dr	765[13.7 L	804 8.2 Jo
793 7.9 Ch	203226	776 12.0 L	787 8.3 Bl	806[13.9 Br	806 8.7 Ah
795 8.2 Wd	795 9.3 Pt	795 13.5 Pt	791 8.2 Dr	820[13.9 Br	808 8.6 Sw
800 8.0 Jo	823 8.6 Pt	799 12.6 Br	799 7.9 Dr	834[13.9 Br	809 8.8 Wd
800 8.8 Wd	R MIC	804 13.6 L	808 8.4 Dr	RS AQR	810 8.5 Ah
801 7.8 Sp	*203429*	823 14.7 Pt	S DEL	*210504*	816 8.2 Ah
804 7.9 Jo	742 11.2 Bl	834 14.1 Br	205017	772 13.3 L	819 8.4 Gy
807 8.4 Jo	775 13.1 Bl	V AQR	765 10.0 L	776 13.2 L	820 7.3 Jo
809 8.6 Wd	790[12.8 Bl	204102	776 10.2 L	795 12.8 Pt	824 7.4 Jo
816 8.7 Wd	Y DEL	765 8.7 L	795 9.8 Pt	804 11.7 L	824 8.4 Wd
820 8.3 Sf	203611	776 8.6 L	804 10.2 L	806 11.6 Ty	828 7.6 Pt
820 7.7 Jo	776 11.4 L	795 9.4 Pt	819 10.3 Br	810 11.2 Wn	831 7.2 Jo
822 7.9 Sp	792 10.0 Pt	804 9.0 L	828 11.3 Pt	812 11.4 Ty	840 8.2 Wd
823 7.8 Pt	799 10.4 Br	823 9.3 Pt	RR CAP	828 10.4 Pt	RR AQR
824 8.0 Wd	804 10.3 L	W AQR	*205627*	Z CAP	*210903*
826 7.7 Jo	829 10.6 Lg	*204104*	765 10.8 Dr	*210516*	765 13.5 L
828 7.9 Sf	S DEL	686 12.6 Nz	780 9.6 Dr	771 11.4 Nz	776 14.2 L
840 8.0 Wd	203816	701 12.4 Nz	791 9.3 Dr	736 14.8 Nz	804 12.9 L
U MIC	770 11.5 Lj	736 11.4 Nz	799 9.3 Dr	743 14.0 Nz	828 10.8 Pt
202240	771 11.6 Lj	743 11.0 Nz	808 9.4 Dr	752 14.8 Nz	Y PAV
742 12.4 Bl	774 11.7 Lj	752 10.6 Nz	T OCT	828 10.3 Pt	*211570*
765 9.0 Dr	776 11.7 Lj	765 9.7 L	*205782*	R EQU	743 5.5 Ht
775 8.6 Bl	779 11.2 Lj	776 9.1 L	766 9.8 Dr	210812	771 5.9 Ht
780 8.5 Dr	780 11.6 Lj	804 9.5 L	780 10.9 Dr	692 12.8 Nz	778 6.7 Ht
787 8.5 Bl	788 11.6 Lj	U CAP	791 11.4 Dr	701 12.2 Nz	X PEG
791 8.5 Dr	791 11.6 Lj	*204215*	799 12.2 Dr	736 9.4 Nz	211614
799 8.6 Dr	795 11.5 Pt	742 10.3 Bl	R VUL	743 9.0 Nz	765 9.3 L
808 8.5 Dr	795 11.7 Lj	765 11.8 L	205923a	752 8.8 Nz	776 9.3 L
RW CYG	796 11.7 Lj	775 12.0 Bl	764 8.5 Ah	765 9.1 L	795 9.8 Pt
202539	802 11.6 Lj	776 12.6 L	774 7.8 Ah	776 9.2 L	804 10.1 L
754 9.3 Sc	805 11.5 Lj	V DEL	775 7.8 Ah	795 9.9 Pt	820 12.3 Br
789 9.3 Sc	806 11.6 Lj	204318	790 8.2 Ch	804 10.5 L	828 10.1 L
792 9.4 Sc	807 11.6 Lj	776[13.6 L	791 8.4 Ah	810 11.5 Wn	834 13.1 Br
819 8.9 An	809 11.7 Lj	799[14.4 Br	795 8.2 Pt	820 12.1 Br	T CAP
RU CAP	813 11.5 Lj	800[13.7 Lg	820 11.2 Br	828 12.6 Pt	*211615*
202622	823 11.4 Pt	810 14.5 Wn	828 11.6 Pt	834 13.1 Br	742 13.2 Bl
686 9.5 Nz	824 11.2 Lj	819[14.4 Br	V CAP	T CEP	765 10.8 L
692 9.5 Nz	V CYG	834[14.4 Br	*210124*	210868	775[12.7 Bl
701 10.4 Nz	203847	T AQR	742 9.8 Bl	764 10.0 Ah	776 9.9 L
736 12.7 Nz	776 10.4 L	*204405*	765 9.7 Dr	769 9.9 Ah	804 10.0 L
743 12.5 Nz	780 10.2 Ch	795 7.6 Pt	775 10.0 Bl	773 9.5 Gy	S MIC
752 12.5 Nz	793 9.9 Ch	820 8.0 Jo	780 10.0 Dr	774 9.6 Ah	*212030*
	795 9.0 Pt	822 8.7 Sp	787 10.3 Bl	775 9.5 Ah	742[13.4 Bl
	806 9.5 Br	823 8.2 Pt	799 11.0 Dr	779 9.1 Ch	775[13.4 Bl

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Y CAP	RU CYG	Y PEG	R IND	W PEG	RR CAS
212814	213753	220613	*222867*	231425	235053
742[13.1 Bl	795 8.5 Pt	701[12.4 Nz	771 10.8 Ht	791 10.6 L	781 11.3 Bn
766 12.9 L	828 8.6 Pt	743[13.9 Nz	775 10.1 Bl	807 9.6 L	801 11.3 Bn
775 12.4 Bl	831 8.6 Bw	752[14.8 Nz	778 10.0 Ht	S PEG	806 11.2 Bn
776 12.3 L	RV CYG	776[13.7 L	780 9.8 Dr	231508	810 11.3 Bn
804 11.9 L	213937	799[13.7 Br	787 9.9 Bl	764 8.5 Ah	822 11.2 Bn
W CYG	766 6.9 L	805[13.3 L	791 9.6 Dr	770 8.3 L	823 11.1 Br
213244	791 6.8 L	810 13.8 Wn	799 9.6 Dr	774 8.2 Ah	837 10.9 Bn
766 5.9 L	795 6.6 Pt	828 12.5 Pt	808 10.0 Dr	791 8.4 Ah	R PHE
771 6.1 Kd	801 6.8 L	834 12.3 Br	T TUC	791 8.2 L	*235150*
772 5.9 L	828 6.5 Pt	RS PEG	*223462*	795 8.8 Pt	765 8.3 Dr
772 6.1 Kd	RR PEG	220714	765 13.2 Dr	807 9.7 Ah	780 8.9 Dr
781 6.2 Kd	214024	701 11.8 Nz	771 12.8 Ht	807 8.8 L	791 9.8 Dr
783 5.7 L	795 10.9 Pt	743 9.0 Nz	R LAC	828 9.5 Pt	799 10.3 Dr
789 6.2 Kd	820 12.6 Br	752 8.6 Nz	223841	V PHE	V CET
790 5.8 L	828 12.8 Pt	767 9.8 L	805 13.9 L	*232746*	*235209*
791 6.1 Kd	R GRU	776 10.1 L	RW PEG	771[13.2 Ht	742 11.7 Bl
793 6.1 Kd	*214247*	795 11.0 Pt	225914	Z AND	770 9.6 L
795 5.5 Gt	742 10.1 Bl	799 10.7 Br	752 13.0 Nz	232848	775 9.7 Bl
801 5.6 L	765 11.4 Dr	805 10.8 L	799 13.5 Wn	795 9.5 Pt	787 10.0 Bl
805 6.2 Kd	771 12.1 Ht	810 10.8 Wn	810 14.1 Wn	810 10.1 Wn	R TUC
806 5.5 Gt	775 12.1 Bl	828 11.5 Pt	R PEG	828 9.8 Pt	*235265*
807 6.1 Kd	778 12.4 Ht	834 11.1 Br	230110	831 10.1 Bw	771 12.7 Ht
808 6.1 Kd	780 12.0 Dr	R PSA	752 10.7 Nz	ST AND	780 13.1 Dr
815 6.0 Kd	790 12.7 Bl	*221230*	764 9.6 Ah	233335	R CAS
817 6.0 Kd	799 12.8 Dr	780[13.3 Dr	773 8.8 Gy	776 9.0 Lj	235350
817 5.4 Gt	V PEG	799 13.5 Dr	774 8.8 Ah	780 9.0 Lj	799 12.4 Wn
817 5.9 An	215605	X AQR	791 8.1 Ah	791 9.0 Lj	810 11.5 Wn
817 5.6 L	766 8.6 L	*221321*	792 8.3 Sf	795 8.5 Pt	829 11.7 Br
819 6.0 Kd	776 8.5 L	743 13.6 Nz	795 8.1 Pt	796 9.0 Lj	Z PEG
823 6.1 Kd	795 9.6 Pt	752 13.2 Nz	796 8.0 Sf	802 9.0 Lj	235525
824 6.0 Kd	796 9.3 L	S GRU	798 8.2 Gb	803 9.0 Lj	770 8.2 L
S CEP	807 9.9 L	*221948*	804 8.0 Sf	806 9.0 Lj	776 8.5 Lj
213678	824 10.8 Sp	765 7.7 Dr	807 8.0 Ah	809 9.0 Lj	780 8.5 Lj
734 9.6 By	828 11.0 Pt	771 7.8 Ht	809 8.0 Sf	813 9.1 Lj	791 8.6 Lj
738 9.6 By	U AQR	778 8.1 Ht	810 8.0 Wn	824 9.1 Lj	791 8.1 L
742 9.6 By	*215717*	780 8.0 Dr	823 8.2 Gy	828 8.7 Pt	795 8.4 Pt
753 9.6 By	770 11.8 L	791 8.4 Dr	823 8.2 Gb	R AQR	796 8.6 Lj
764 9.7 Ah	776 11.9 L	793 8.8 En	827 8.4 Sf	*233815*	802 8.7 Lj
774 9.6 Ah	795 12.0 Pt	799 8.7 Dr	828 8.2 Pt	742 7.9 Bl	804 8.7 Lj
780 9.8 By	796 11.9 L	RV PEG	V CAS	770 7.9 L	807 8.8 L
789 9.5 Jo	828 12.2 Pt	222129	230759	771 7.9 Ht	808 8.8 Lj
795 9.0 Pt	RT PEG	770 13.3 L	764 9.9 Ah	775 7.8 Bl	824 9.1 Lj
801 9.4 Jo	215934	805 13.8 L	769 9.6 Ah	787 8.0 Bl	828 9.3 Pt
804 9.7 Jo	766 10.3 L	810 13.8 Wn	774 9.6 Ah	791 8.1 L	Y CAS
820 10.0 Br	776 10.6 L	S LAC	775 9.4 Ah	795 8.5 Pt	235855
820 9.2 Jo	805 11.2 L	222439	781 9.1 Ah	813 8.6 L	770[12.9 L
826 10.2 Sf	828 11.6 Pt	770 12.9 L	791 8.6 Ah	828 8.8 Pt	810 13.8 Wn
826 9.4 Jo	RZ PEG	791 12.2 L	795 8.1 Pt	Z CAS	834 14.7 Br
828 9.0 Pt	220133b	795 11.5 Pt	798 7.8 Sw	233956	SV AND
831 9.5 Jo	767 12.2 L	805 11.3 L	799 8.3 Wn	823[13.4 Br	235939
RU CYG	776 12.6 L	828 9.5 Pt	808 7.9 Sw	834 14.4 Br	795 9.1 Pt
213753	T PEG	R IND	810 7.9 Wn	RR CAS	828 9.8 Pt
764 8.1 Ah	220412	*222867*	810 8.0 Ah	235053	831 10.7 Bw
774 8.2 Ah	766 10.1 L	742 12.8 Bl	816 8.8 Ah	773 11.2 Bn	834 10.7 Br
775 8.1 Ah	776 10.6 L	764 10.7 Bl	823 8.0 Br		
791 8.4 Ah	805 12.3 L	765 11.0 Dr	828 8.0 Sf		
	806 11.9 Ty		828 7.7 Pt		

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840 RX ANDROMEDAE—						
	5778.8	11.7	Pt	5823.7	11.5	Pt
	5791.7	11.6	Pt	5827.7	11.5	Pt
	5795.8	11.5	Pt	5831.7	11.5	Pt
	5801.9	11.5	Pt	5834.8	11.7	Pt
010884 RU CEPHEI—						
	5773.5	8.7	L	5802.3	9.0	L
	5791.6	8.7	L	5807.6	9.0	L
	5802.3	8.9	Be			
060547 SS AURIGAE—						
	5672.1	12.1	Nz	5739.1	13.0	Nz
	5673.1	12.7	Nz	5739.6	13.0	GC
	5674.1	13.8	Nz	5748.1	14.5	Nz
	5675.1	13.9	Nz	5767.3[	12.4	L
	5676.1	14.2	Nz	5768.3[	12.0	L
	5677.1	14.6	Nz	5770.3[	12.4	L
	5678.1	14.8	Nz	5772.3[	12.4	L
	5683.1	15.2	Nz	5774.3[	12.4	L
	5687.1	14.8	Nz	5796.6[	10.8	L
	5697.1[	14.5	Nz	5803.6[	12.4	L
	5699.1	15.2	Nz	5804.6[	10.8	L
	5733.1	11.1	Nz	5808.6[	12.4	L
	5733.6	11.0	GC	5813.6[	11.5	L
	5734.1	11.2	Nz	5815.6[	12.4	L
	5735.6	11.0	GC	5816.6[	12.0	L
	5736.1	11.4	Nz	5827.9[	12.4	Pt
	5736.1	11.2	Ch	5831.9[	11.2	Pt
	5736.6	11.3	GC	5834.9	12.1	Br
	5737.1	12.6	Nz			
074922 U GEMINORUM—						
	5674.1	13.7	Nz	5763.1	9.1	Ch
	5675.1	13.7	Nz	5764.3	8.7	L
	5682.1	13.9	Nz	5766.3	8.9	L
	5687.1	13.9	Nz	5767.3	9.0	L
	5697.2	13.6	Nz	5768.3	9.0	L
	5699.1	13.6	Nz	5769.3	9.3	L
	5733.6	13.9	GC	5770.3	9.4	L
	5736.6[	12.2	GC	5770.4	9.8	An
	5739.6[	13.7	GC	5771.3	9.5	L
	5742.1[	10.9	Ch	5772.3	9.6	L
	5744.1[	13.3	Ch	5774.3	10.1	L
	5749.1[	12.4	Ch	5775.3[	10.0	L
081473 Z CAMELOPARDALIS—						
	5763.5	11.2	L	5776.3	12.6	L
	5765.6	11.3	L	5777.6	11.8	L
	5766.3	11.5	L	5783.5	11.2	L
	5766.3	11.5	Be	5784.3	11.3	L
	5767.3	12.0	L	5790.4	11.3	L
	5767.6	12.0	L	5791.5	11.3	L
	5768.3	12.1	L	5794.3	11.5	Gt
	5769.3	12.0	L	5794.3	11.3	Be
	5770.3	12.4	L	5794.4	11.3	L
	5770.4	12.4	Be	5794.4	11.4	An
	5770.4	12.1	An	5795.4	11.3	L
	5771.3	12.4	L	5798.3	11.4	Gt
	5772.3	12.4	L	5798.4	11.5	An
	5773.3	12.7	L	5798.4	11.5	Be
	5774.3	12.5	L	5798.4	11.3	L
	5775.3	12.9	L	5801.4	11.2	L
081473 Z CAMELOPARDALIS—						
	5801.4	11.4	An	5810.6	11.6	L
	5802.4	11.3	Be	5812.4	11.4	L
	5802.4	11.3	L	5813.3	11.8	Gt
	5803.6	11.4	L	5813.4	11.4	L
	5804.4	11.5	L	5815.4	11.4	L
	5805.4	11.5	L	5815.4	11.5	An
	5806.3	11.2	Gt	5816.4	11.2	L
	5807.4	11.3	L	5816.6	11.3	L
	5808.4	11.5	L	5817.4	11.2	L
	5809.4	11.3	L	5818.4	11.2	L
	5809.4	11.2	Gt	5819.4	11.3	An
094512 X LEONIS—						
	5766.3[	12.5	Be	5771.3	12.0	L
	5767.3[	14.2	L	5772.3	12.0	L
	5766.3[	14.2	L	5773.3	12.1	L
	5768.3	13.0	L	5774.3	12.0	L
	5769.3	12.3	L	5775.3	12.3	L
	5770.3	11.9	L	5776.3[	12.3	L
202946 SZ CYGNI—						
	5778.8	9.0	Pt	5811.7	9.0	Pt
	5780.7	9.2	Pt	5812.7	9.2	Pt
	5781.8	9.2	Pt	5814.7	9.2	Pt
	5782.7	9.2	Pt	5815.7	9.2	Pt
	5783.7	9.3	Pt	5818.7	9.6	Pt
	5784.7	9.3	Pt	5821.7	9.2	Pt
	5788.7	9.4	Pt	5822.7	9.5	Pt
	5789.7	9.6	Pt	5823.7	9.0	Pt
	5791.7	9.5	Pt	5824.7	9.0	Pt
	5795.7	9.2	Pt	5827.7	9.2	Pt
	5801.7	9.2	Pt	5828.7	9.4	Pt
	5805.7	9.3	Pt	5830.7	9.4	Pt
	5809.7	9.2	Pt	5831.7	9.4	Pt
	5810.7	9.2	Pt	5834.8	9.6	Pt
213843 SS CYGNI—						
	5743.3	9.2	Ch	5776.6	11.5	L
	5760.9	12.0	Wk	5777.4	11.5	Be
	5763.6	11.6	L	5777.4	11.9	An
	5764.5	11.8	Ah	5777.6	11.4	L
	5765.6	11.5	L	5778.8	11.6	Pt
	5765.9	12.0	Wk	5779.4	11.9	Li
	5766.6	11.5	L	5780.5	11.9	Lj
	5767.6	11.5	L	5780.7	11.7	Pt
	5770.4	11.4	L	5781.2	11.5	Ch
	5770.4	11.2	Be	5781.4	11.9	Lj
	5770.4	11.2	An	5781.8	11.7	Pt
	5770.5	11.7	Lj	5782.7	11.7	Pt
	5771.4	11.9	Lj	5783.5	10.9	L
	5771.6	11.5	L	5783.7	11.7	Pt
	5771.7	11.8	Sp	5784.3	11.3	L
	5772.5	11.5	L	5784.7	11.7	Pt
	5774.4	11.9	Lj	5788.5	11.9	Lj
	5774.4	11.5	Ah	5788.7	11.7	Pt
	5774.6	11.4	L	5789.4	11.9	Lj
	5775.4	11.8	Lj	5789.7	11.0	Jo
	5775.5	11.7	Ah	5789.7	11.6	Pt
	5775.6	11.5	L	5802.4	9.5	L
	5776.4	11.9	Lj	5802.4	9.0	Gt
	5776.5	12.0	Lj	5803.4	10.0	Lj

RAPIDLY VARYING IRREGULAR VARIABLES

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—							213843 SS CYGNI—						
	5803.7	10.2	Mo	5813.4	11.9	Lj		5798.4	8.5	Be	5822.7	11.7	Pt
	5803.7	10.2	Sd	5813.4	11.8	Gt		5798.4	8.5	L	5823.7	11.6	Br
	5803.7	10.9	Ma	5814.7	11.7	Pt		5798.4	8.4	Gt	5823.7	11.2	Ma
	5804.4	10.9	Lj	5815.4	11.6	L		5798.4	8.4	An	5823.7	11.7	Pt
	5804.4	10.2	L	5815.4	12.1	An		5799.6	8.5	Sf	5824.3	11.2	Lj
	5804.7	11.0	Sb	5815.7	11.6	Pt		5799.7	9.1	Wn	5824.4	10.9	An
	5804.7	10.3	Jo	5817.4	11.4	Gt		5799.7	9.1	Br	5824.4	11.1	Lj
	5805.4	10.9	L	5817.4	11.5	L		5800.6	8.6	Sf	5824.6	11.7	Sp
	5805.6	11.1	Lj	5817.4	11.9	An		5800.7	8.5	Jo	5824.7	11.6	Br
	5805.7	11.5	Pt	5817.7	11.7	Br		5800.9	9.2	Lg	5824.7	11.6	Ma
	5805.7	11.0	Ma	5790.2	11.7	Ch		5801.4	9.1	L	5824.7	11.7	Pt
	5806.4	11.4	Ah	5790.5	11.6	L		5801.4	8.8	Gt	5825.7	11.7	Br
	5806.4	11.4	Lj	5791.4	11.9	Lj		5801.4	9.0	An	5825.7	11.8	Lg
	5806.8	11.7	Br	5791.4	11.6	Ah		5801.6	9.6	Sp	5827.7	11.7	Pt
	5807.2	11.9	Ch	5791.5	11.4	L		5801.7	9.4	Mo	5828.7	11.7	Br
	5807.4	11.3	L	5791.7	11.6	Pt		5801.7	9.8	Sd	5828.7	11.6	Pt
	5807.4	11.9	Lj	5792.8	11.7	Br		5801.7	9.2	Sw	5828.8	11.3	Ma
	5807.7	11.8	Jo	5792.9	10.7	Lg		5801.7	9.4	Jo	5829.7	12.0	Lg
	5808.2	11.8	Ch	5794.2	11.6	Ch		5801.7	9.5	Pt	5829.7	11.7	Br
	5808.4	11.6	Ah	5794.5	10.9	L		5802.2	9.6	Ch	5830.7	11.7	Pt
	5808.4	11.8	Lj	5795.2	8.5	Ch		5802.4	9.3	Be	5830.7	11.9	Br
	5808.6	11.9	L	5795.4	8.8	Be		5802.4	10.1	Lj	5831.6	12.0	Fd
	5808.7	11.6	Gt	5795.4	8.6	Gt		5817.7	11.7	Pt	5831.7	11.8	Br
	5808.7	11.8	Ma	5795.4	8.8	L		5818.7	11.6	Pt	5831.7	11.7	Pt
	5809.4	11.8	Lj	5795.5	8.7	Lj		5819.4	11.0	An	5832.7	11.8	Br
	5809.4	11.6	L	5795.6	8.4	Sf		5819.7	11.2	Br	5833.7	12.0	Lg
	5809.4	11.6	Gt	5795.7	8.7	Pt		5820.3	11.5	Br	5833.7	11.9	Br
	5809.7	11.7	Pt	5796.4	8.4	Lj		5820.7	11.7	Jo	5834.4	10.8	Gt
	5810.6	11.9	L	5796.5	8.6	L		5820.8	11.4	Ma	5834.7	12.0	Br
	5810.8	11.7	Wn	5796.6	8.3	Sf		5821.7	11.7	Pt	5834.7	11.9	Lg
	5811.7	11.7	Pt	5796.7	8.4	Ma		5822.7	11.8	Sp	5834.8	11.6	Pt
	5812.7	11.7	Pt	5797.6	8.3	Sf		5822.7	11.5	Jo	5836.7	11.9	Br
											5839.8	11.1	Ma

SUMMARY OF OBSERVATIONS, JULY-AUGUST, 1929.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	35	170	Haas	Hs	8	25
Ancarani	An	21	40	Houghton	Ht	64	257
Baldwin	Bl	100	430	Jones	Jo	42	220
Benini	Be	19	42	Kanamori	Km	1	6
Beyer	By	9	74	Kanda	Kd	7	72
Bigelow	Bw	25	47	Lacchini	L	160	522
Boutell	BL	7	27	Leiner	Lj	13	203
Brocchi	Br	65	105	Logan	Lg	47	124
Brown	Bn	3	17	Marsh	Ma	12	29
Buckstaff	Bk	19	43	Millard	Md	9	20
Chandra	Ch	82	182	Monnig	Mo	12	20
Dartayet	Dr	90	310	Nizamiah Obs	Nz	31	168
Dawson	Dw	16	18	Peltier	Pt	175	469
Ensor	En	67	210	Sanders	Sd	8	13
Ford	Fd	8	11	Schoenfeld	Sc	14	31
Gaebler	Gb	7	17	Smith, F. W.	Sf	17	44
Gallanti	Gt	10	29	Smith, W. H.	Sm	44	76
Georgetown Observatory	GC	14	41	Soberanes	Sb	1	1
Goodsell	Gs	5	5	Spears	Sp	20	39
Gregory	Gy	9	19	Swanson	Sw	18	31
				Taylor	Ty	18	30

Waterfield	Wf	1	5	Zaldo	Za	2	5
Watkins	Wk	18	21				
Webb	Wd	13	83	Total	46	417	4402
Wilson	Wn	35	51				

September 12, 1929.

LEON CAMPBELL, Recording Secretary.

Co-operative Observing of Cepheid Variables.

The inauguration of this phase of astronomical work was referred to on page 421 of the preceding issue. According to Circular Letter No. 2, recently sent out from the Harvard College Observatory, more than a dozen observatories are now working on some phase of the systematic study of the selected Cepheid variables. Visual as well as photographic programs are in operation. More workers are desired in order that the survey for irregularities may be conclusive, and the interruptions by weather be not too serious. Suggestions concerning details of the work have been received from various participators. The Harvard College Observatory is prepared to furnish to any observers, who are interested in this project, certain recommendations that should help in the successful prosecution of the work.

GENERAL NOTES.

Professor Asaph Hall, for many years astronomer at the U. S. Naval Observatory, has recently retired. He is making his home at Upper Darby, Pennsylvania, where he is actively continuing certain work, using the instruments at the Flower Observatory.

Dr. George P. Merrill, a noted geologist, died suddenly at Auburn, Maine, on August 15, at the age of seventy-five years. At the time of his death Dr. Merrill was head curator of geology in the United States National Museum, Washington, D. C. He had written extensively on geologic subjects and was a recognized authority on questions related to meteorites.

Zodiacal Light Observations.

Observers are reminded that the time of year has come for satisfactory observations of the Gegenschein and the morning Zodiacal Light. Reports will be welcome.

From Professor Ivan L. Thomsen, Dominion Observatory, Kelburn, Wellington, New Zealand, a communication has been received promising coöperation in Zodiacal Light observations. He writes: "We will try to form a Section in our Astronomical Society for this work. I have issued a circular to members of the New Zealand Astronomical Society and I sincerely hope that they will respond and that we will coöperate." Copies of the circular were enclosed.

James W. Hanahan, Esq., attorney-at-law, Winnsboro, South Carolina, has kindly sent reports of a series of observations made by him between January 29 and April 27, 1913. These reports, accompanied by diagrams, are exceedingly interesting. A careful inspection of them shows the following noteworthy features:

1. *The Fact of the Lunar Zodiacal Light:* "March 22: At 7:00 o'clock this evening the light could be distinctly seen in the east. The moon was below the horizon. It (the light) was bright and was located where the Gegenschein ought to be seen but was much brighter than the Gegenschein. It appeared to be broader at the base than the Zodiacal Light."

"March 23: Moonrise, 8:30. At 8:00 o'clock the light was a well-defined

cone pretty regular in outline. It gradually brightened until about 8:15 when it was brightest. Then as the moon rose it paled and spread."

Other Lunar Zodiacal Light observations were made on April 21, 22, 23, and 24. In his report for April 23 Mr. Hanahan says: "While the seeing was very fine tonight the light was not as bright as on April 20, 21, and 22, doubtless due to the moon not giving so much light."

2. *The Gegenschein:* "April 1: Gegenschein well seen but fainter than usual when conditions are as favorable as tonight. It appeared also smaller than usual"—due perhaps to its faintness.

"April 6: Zodiacal band extended across the heavens and joined the Gegenschein in the east. Seeing fine."

3. *Fluctuations:* "Evening Zodiacal Light, Feb. 4. The whole mass of the light tonight at several times would grow dim and after a few minutes would become brighter. There was no sparkle or pulsation. As a whole it would wax and wane in brilliancy. Sometimes it would grow so faint as to be seen with difficulty."

"Feb. 13, evening. At times the Zodiacal Light paled so much as to be difficult to see and then the whole light would grow bright again."

"March 5, evening. The whole light dimmed and then brightened at times, but not regularly. There seems to be no rule. A maximum dimming is not followed by a maximum brightening."

"March 7, evening. No brightening or dimming tonight. Light steady. The earlier the observation, the wider the base of the cone especially when the ecliptic lies more nearly along the horizon."

More than once in the course of his reports Mr. Hanahan notes that the band of light could be seen clear across the sky and became fainter as night progressed. Also, Venus was in the western sky during this series of observations and Mr Hanahan is moved to exclaim: "Venus is very troublesome." "I wish Venus were out of the way." Other observers have been similarly moved!

W. E. Glanville.

The Rectory, New Market, Maryland.

BOOK REVIEW.

Physics of the Air by W. J. Humphreys. New second edition, 654 pp. McGraw-Hill Book Company, New York, 1929.

The general scientific world has already been informed of this new edition of Professor Humphrey's well-known book. This review is intended primarily for those who may not have seen the usual announcements. In this volume the physical forces and concepts underlying the study of the earth's atmosphere are considered. Some of the subjects considered are: Observations, Why the Temperature of the Atmosphere decreases with Increase of Height, The Isothermal Region, Atmospheric Circulation, How Raindrops are formed, Fogs and clouds, The Thunderstorm, Lightning, Aurora Polaris, Refraction Phenomena, Mirage, Rainbows, Halos, Color of the Sky, Factors of Climatic Control, and many others. Some parts are highly technical but there is a great deal that would prove of great interest to the teacher of physical geography or general science in the High School as well as to the general reader. The book can be recommended to all who wish exact information on the general subject considered. It is carefully written by one of the country's leading scientists and is fully illustrated. E.A.F.